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(54) 【発明の名称】 樹脂被覆式管内面補修方法および樹脂被覆式管内面補修装置

(57) 【要約】

【目的】 管路内の破損箇所の樹脂被覆補修にあたり、破損箇所のみの樹脂被覆で、補修コストの低減を図ること。

【構成】 ゴム管体の外周面に補修体を取付けたのち、ワイヤー牽引により管路内の破損箇所へ移動させる。ゴム管体に加圧空気を供給してゴム管体を膨張させて破損箇所の管路内壁に圧接させる。ゴム管体の補修体近傍の温度を計測して制御装置に入力して線状ヒーターによるゴム管体の加熱を制御して補修体の温度を所定範囲温度に維持しつつ所定時間補修体を加熱する。

【効果】 管路内の破損箇所のみに遠隔操作で樹脂被覆し、且つ最適温度範囲に維持して樹脂を硬化させることで、強固な樹脂被覆を形成して樹脂被覆補修を完全にする。

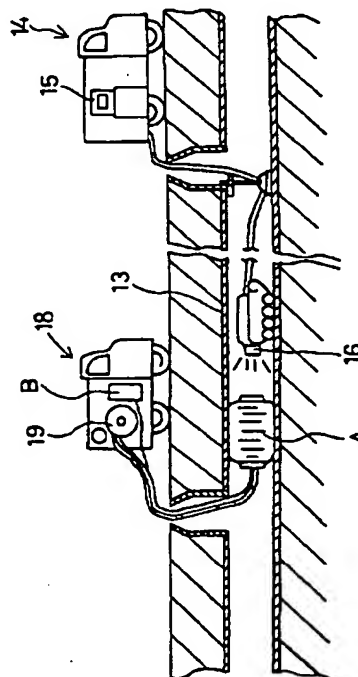


図1は、樹脂被覆式管内面補修装置の概略図を示す。図中、Aは管路、Bは補修体、Cは加熱装置、Dは温度計測部、Eは制御装置、Fはワイヤー、Gは圧力源、Hは膨張管、Iは加熱体、Jは温度センサー、Kは温度制御部、Lは温度表示部、Mは温度設定部、Nは温度記憶部、Oは温度比較部、Pは温度出力部、Qは温度入力部、Rは温度処理部、Sは温度監視部、Tは温度报警部、Uは温度記録部、Vは温度削除部、Wは温度検索部、Xは温度更新部、Yは温度バックアップ部、Zは温度リセット部、AAは温度初期化部、ABは温度終了部、ACは温度キャンセル部、ADは温度中断部、AEは温度再開部、AFは温度完了部、AGは温度エラー部、AHは温度警告部、AIは温度異常部、AJは温度故障部、AKは温度停止部、ALは温度起動部、AMは温度動作部、ANは温度待機部、AOは温度休眠部、APは温度スタンバイ部、AQは温度オフ部、ARは温度オン部、ASは温度ロック部、ATは温度アンロック部、AUは温度パスワード部、AVは温度セキュリティ部、AWは温度認証部、AXは温度認可部、AYは温度拒否部、AZは温度承認部、BAは温度承認部、BBは温度承認部、BCは温度承認部、BDは温度承認部、BEは温度承認部、BFは温度承認部、BGは温度承認部、BHは温度承認部、BIは温度承認部、BJは温度承認部、BKは温度承認部、BLは温度承認部、BMは温度承認部、BNは温度承認部、BOは温度承認部、BPは温度承認部、BQは温度承認部、BRは温度承認部、BSは温度承認部、BTは温度承認部、BUは温度承認部、BVは温度承認部、BWは温度承認部、BXは温度承認部、BYは温度承認部、BZは温度承認部、CAは温度承認部、CBは温度承認部、CCは温度承認部、CDは温度承認部、CEは温度承認部、CFは温度承認部、CGは温度承認部、CHは温度承認部、CIは温度承認部、CJは温度承認部、CKは温度承認部、CLは温度承認部、CMは温度承認部、CNは温度承認部、COは温度承認部、CPは温度承認部、CQは温度承認部、CRは温度承認部、CSは温度承認部、CTは温度承認部、CUは温度承認部、CVは温度承認部、CWは温度承認部、CXは温度承認部、CYは温度承認部、CZは温度承認部、DAは温度承認部、DBは温度承認部、DCは温度承認部、DDは温度承認部、DEは温度承認部、DFは温度承認部、DGは温度承認部、DHは温度承認部、DIは温度承認部、DJは温度承認部、DKは温度承認部、DLは温度承認部、DMは温度承認部、DNは温度承認部、DOは温度承認部、DPは温度承認部、DQは温度承認部、DRは温度承認部、DSは温度承認部、DTは温度承認部、DUは温度承認部、DVは温度承認部、DWは温度承認部、DXは温度承認部、DYは温度承認部、DZは温度承認部、EAは温度承認部、EBは温度承認部、ECは温度承認部、EDは温度承認部、EEは温度承認部、EFは温度承認部、EGは温度承認部、EHは温度承認部、EIは温度承認部、EJは温度承認部、EKは温度承認部、ELは温度承認部、EMは温度承認部、ENは温度承認部、EOは温度承認部、EPは温度承認部、EQは温度承認部、ERは温度承認部、ESは温度承認部、ETは温度承認部、EUは温度承認部、EVは温度承認部、EWは温度承認部、EXは温度承認部、EYは温度承認部、EZは温度承認部、FAは温度承認部、FBは温度承認部、FCは温度承認部、FDは温度承認部、FEは温度承認部、FFは温度承認部、FGは温度承認部、FHは温度承認部、FIは温度承認部、FJは温度承認部、FKは温度承認部、FLは温度承認部、FMは温度承認部、FNは温度承認部、FOは温度承認部、FPは温度承認部、FQは温度承認部、FRは温度承認部、FSは温度承認部、FTは温度承認部、FUは温度承認部、FVは温度承認部、FWは温度承認部、FXは温度承認部、FYは温度承認部、FZは温度承認部、GAは温度承認部、GBは温度承認部、GCは温度承認部、GDは温度承認部、GEは温度承認部、GFは温度承認部、GGは温度承認部、GHは温度承認部、GIは温度承認部、GJは温度承認部、GKは温度承認部、GLは温度承認部、GMは温度承認部、GNは温度承認部、GOは温度承認部、GPは温度承認部、GQは温度承認部、GRは温度承認部、GSは温度承認部、GTは温度承認部、GUは温度承認部、GVは温度承認部、GWは温度承認部、GXは温度承認部、GYは温度承認部、GZは温度承認部、HAは温度承認部、HBは温度承認部、HCは温度承認部、HDは温度承認部、HEは温度承認部、HFは温度承認部、HGは温度承認部、HHは温度承認部、HIは温度承認部、HJは温度承認部、HKは温度承認部、HLは温度承認部、HMは温度承認部、HNは温度承認部、HOは温度承認部、HPは温度承認部、HQは温度承認部、HRは温度承認部、HSは温度承認部、HTは温度承認部、HUは温度承認部、HVは温度承認部、HWは温度承認部、HXは温度承認部、HYは温度承認部、HZは温度承認部、IAは温度承認部、IBは温度承認部、ICは温度承認部、IDは温度承認部、IEは温度承認部、IFは温度承認部、IGは温度承認部、IHは温度承認部、IIは温度承認部、IJは温度承認部、IKは温度承認部、ILは温度承認部、IMは温度承認部、INは温度承認部、IOは温度承認部、IPは温度承認部、IQは温度承認部、IRは温度承認部、ISは温度承認部、ITは温度承認部、IUは温度承認部、IVは温度承認部、IWは温度承認部、IXは温度承認部、IYは温度承認部、IZは温度承認部、JAは温度承認部、JBは温度承認部、JCは温度承認部、JDは温度承認部、JEは温度承認部、JFは温度承認部、JGは温度承認部、JHは温度承認部、JIは温度承認部、JJは温度承認部、JKは温度承認部、JLは温度承認部、JMは温度承認部、JNは温度承認部、JOは温度承認部、JPは温度承認部、JQは温度承認部、JRは温度承認部、JSは温度承認部、JTは温度承認部、JUは温度承認部、JVは温度承認部、JWは温度承認部、JXは温度承認部、JYは温度承認部、JZは温度承認部、KAは温度承認部、KBは温度承認部、KCは温度承認部、KDは温度承認部、KEは温度承認部、KFは温度承認部、KGは温度承認部、KHは温度承認部、KIは温度承認部、KJは温度承認部、KKは温度承認部、KLは温度承認部、KMは温度承認部、KNは温度承認部、KOは温度承認部、KPは温度承認部、KQは温度承認部、KRは温度承認部、KSは温度承認部、KTは温度承認部、KUは温度承認部、KVは温度承認部、KWは温度承認部、KXは温度承認部、KYは温度承認部、KZは温度承認部、LAは温度承認部、LBは温度承認部、LCは温度承認部、LDは温度承認部、LEは温度承認部、LFは温度承認部、LGは温度承認部、LHは温度承認部、LIは温度承認部、LJは温度承認部、LKは温度承認部、LLは温度承認部、LMは温度承認部、LNは温度承認部、LOは温度承認部、LPは温度承認部、LQは温度承認部、LRは温度承認部、LSは温度承認部、LTは温度承認部、LUは温度承認部、LVは温度承認部、LWは温度承認部、LXは温度承認部、LYは温度承認部、LZは温度承認部、MAは温度承認部、MBは温度承認部、MCは温度承認部、MDは温度承認部、MEは温度承認部、MFは温度承認部、MGは温度承認部、MHは温度承認部、MIは温度承認部、MJは温度承認部、MKは温度承認部、MLは温度承認部、MMは温度承認部、MNは温度承認部、MOは温度承認部、MPは温度承認部、MQは温度承認部、MRは温度承認部、MSは温度承認部、MTは温度承認部、MUは温度承認部、MVは温度承認部、MWは温度承認部、MXは温度承認部、MYは温度承認部、MZは温度承認部、NAは温度承認部、NBは温度承認部、NCは温度承認部、NDは温度承認部、NEは温度承認部、NFは温度承認部、NGは温度承認部、NHは温度承認部、NIは温度承認部、NJは温度承認部、NKは温度承認部、NLは温度承認部、NMは温度承認部、NNは温度承認部、NOは温度承認部、NPは温度承認部、NQは温度承認部、NRは温度承認部、NSは温度承認部、NTは温度承認部、NUは温度承認部、NVは温度承認部、NWは温度承認部、NXは温度承認部、NYは温度承認部、NZは温度承認部、OAは温度承認部、OBは温度承認部、OCは温度承認部、ODは温度承認部、OEは温度承認部、OFは温度承認部、OGは温度承認部、OHは温度承認部、OIは温度承認部、OJは温度承認部、OKは温度承認部、OLは温度承認部、OMは温度承認部、ONは温度承認部、OOは温度承認部、OPは温度承認部、OQは温度承認部、ORは温度承認部、OSは温度承認部、OTは温度承認部、OUは温度承認部、OVは温度承認部、OWは温度承認部、OXは温度承認部、OYは温度承認部、OZは温度承認部、PAは温度承認部、PBは温度承認部、PCは温度承認部、PDは温度承認部、PEは温度承認部、PFは温度承認部、PGは温度承認部、PHは温度承認部、PIは温度承認部、PJは温度承認部、PKは温度承認部、PLは温度承認部、PMは温度承認部、PNは温度承認部、POは温度承認部、PPは温度承認部、PQは温度承認部、PRは温度承認部、PSは温度承認部、PTは温度承認部、PUは温度承認部、PVは温度承認部、PWは温度承認部、PXは温度承認部、PYは温度承認部、PZは温度承認部、QAは温度承認部、QBは温度承認部、QCは温度承認部、QDは温度承認部、QEは温度承認部、QFは温度承認部、QGは温度承認部、QHは温度承認部、QIは温度承認部、QJは温度承認部、QKは温度承認部、QLは温度承認部、QMは温度承認部、QNは温度承認部、QOは温度承認部、QPは温度承認部、QQは温度承認部、QRは温度承認部、QSは温度承認部、QTは温度承認部、QUは温度承認部、QVは温度承認部、QWは温度承認部、QXは温度承認部、QYは温度承認部、QZは温度承認部、RAは温度承認部、RBは温度承認部、RCは温度承認部、RDは温度承認部、REは温度承認部、RFは温度承認部、RGは温度承認部、RHは温度承認部、RIは温度承認部、RJは温度承認部、RKは温度承認部、RLは温度承認部、RMは温度承認部、RNは温度承認部、ROは温度承認部、RPは温度承認部、RQは温度承認部、RRは温度承認部、RSは温度承認部、RTは温度承認部、RUは温度承認部、RVは温度承認部、RWは温度承認部、RXは温度承認部、RYは温度承認部、RZは温度承認部、SAは温度承認部、SBは温度承認部、SCは温度承認部、SDは温度承認部、SEは温度承認部、SFは温度承認部、SGは温度承認部、SHは温度承認部、SIは温度承認部、SJは温度承認部、SKは温度承認部、SLは温度承認部、SMは温度承認部、SNは温度承認部、SOは温度承認部、SPは温度承認部、SQは温度承認部、SRは温度承認部、SSは温度承認部、STは温度承認部、SUは温度承認部、SVは温度承認部、SWは温度承認部、SXは温度承認部、SYは温度承認部、SZは温度承認部、TAは温度承認部、TBは温度承認部、TCは温度承認部、TDは温度承認部、TEは温度承認部、TFは温度承認部、TGは温度承認部、THは温度承認部、TIは温度承認部、TJは温度承認部、TKは温度承認部、TLは温度承認部、TMは温度承認部、TNは温度承認部、TOは温度承認部、TPは温度承認部、TQは温度承認部、TRは温度承認部、TSは温度承認部、TTは温度承認部、TUは温度承認部、TVは温度承認部、TWは温度承認部、TXは温度承認部、TYは温度承認部、TZは温度承認部、UAは温度承認部、UBは温度承認部、UCは温度承認部、UDは温度承認部、UEは温度承認部、UFは温度承認部、UGは温度承認部、UHは温度承認部、UIは温度承認部、UJは温度承認部、UKは温度承認部、ULは温度承認部、UMは温度承認部、UNは温度承認部、UOは温度承認部、UPは温度承認部、UQは温度承認部、URは温度承認部、USは温度承認部、UTは温度承認部、UUは温度承認部、UVは温度承認部、UWは温度承認部、UXは温度承認部、UYは温度承認部、UZは温度承認部、VAは温度承認部、VBは温度承認部、VCは温度承認部、VDは温度承認部、VEは温度承認部、VFは温度承認部、VGは温度承認部、VHは温度承認部、VIは温度承認部、VJは温度承認部、VKは温度承認部、VLは温度承認部、VMは温度承認部、VNは温度承認部、VOは温度承認部、VPは温度承認部、VQは温度承認部、VRは温度承認部、VSは温度承認部、VTは温度承認部、VUは温度承認部、VVは温度承認部、VWは温度承認部、VXは温度承認部、VYは温度承認部、VZは温度承認部、WAは温度承認部、WBは温度承認部、WCは温度承認部、WDは温度承認部、WEは温度承認部、WFは温度承認部、WGは温度承認部、WHは温度承認部、WIは温度承認部、WJは温度承認部、WKは温度承認部、WLは温度承認部、WMは温度承認部、WNは温度承認部、WOは温度承認部、WPは温度承認部、WQは温度承認部、WRは温度承認部、WSは温度承認部、WTは温度承認部、WUは温度承認部、WVは温度承認部、WWは温度承認部、WXは温度承認部、WYは温度承認部、WZは温度承認部、XAは温度承認部、XBは温度承認部、XCは温度承認部、XDは温度承認部、XEは温度承認部、XFは温度承認部、XGは温度承認部、XHは温度承認部、XIは温度承認部、XJは温度承認部、XKは温度承認部、XLは温度承認部、XMは温度承認部、XNは温度承認部、XOは温度承認部、XPは温度承認部、XQは温度承認部、XRは温度承認部、XSは温度承認部、XTは温度承認部、XUは温度承認部、XVは温度承認部、XWは温度承認部、XXは温度承認部、XYは温度承認部、XZは温度承認部、YAは温度承認部、YBは温度承認部、YCは温度承認部、YDは温度承認部、YEは温度承認部、YFは温度承認部、YGは温度承認部、YHは温度承認部、YIは温度承認部、YJは温度承認部、YKは温度承認部、YLは温度承認部、YMは温度承認部、YNは温度承認部、YOは温度承認部、YPは温度承認部、YQは温度承認部、YRは温度承認部、YSは温度承認部、YTは温度承認部、YUは温度承認部、YVは温度承認部、YWは温度承認部、YXは温度承認部、YYは温度承認部、YZは温度承認部、ZAは温度承認部、ZBは温度承認部、ZCは温度承認部、ZDは温度承認部、ZEは温度承認部、ZFは温度承認部、ZGは温度承認部、ZHは温度承認部、ZIは温度承認部、ZJは温度承認部、ZKは温度承認部、ZLは温度承認部、ZMは温度承認部、ZNは温度承認部、ZOは温度承認部、ZPは温度承認部、ZQは温度承認部、ZRは温度承認部、ZSは温度承認部、ZTは温度承認部、ZUは温度承認部、ZVは温度承認部、ZWは温度承認部、ZXは温度承認部、ZYは温度承認部、ZZは温度承認部

## 【特許請求の範囲】

【請求項1】管路内の破損箇所の樹脂被覆を行う樹脂被覆式管内面補修方法において、加圧空気の供給により拡大してその周囲が管路内面に圧着させ得るゴム管体と、該ゴム管体を加熱するためのヒーターおよび温度センサーを有し、管路内を移動自在である管路内壁補修具に、そのゴム管体の外周面に補修体を取付けたのち、管路内を移動するテレビカメラの誘導でワイヤー牽引により管路内の破損箇所へ移動させ、ゴム管体に加圧空気を供給してゴム管体を膨張させて、ゴム管体の外周面を管路内壁に圧接させて、補修体を破損箇所へ管路内壁とゴム管体の外周面とに圧接させ、前記管路内壁補修具における補修体近傍の温度を計測して制御装置に入力して線状ヒーターによる加熱を制御して補修体の温度を所定範囲温度に維持しつつ所定時間補修体を加熱して補修体を硬化させることを特徴とする樹脂被覆式管内面補修方法。

【請求項2】ゴム管体を二重管の筒体の外筒体の外周方に位置して筒体に取り付けて、管路内壁補修具の中心部に貫通孔を形成したことを特徴とする請求項1の、樹脂被覆式管内面補修方法。

【請求項3】ゴム管体を二重管の筒体の外筒体の外周面に線状ヒーターを巻回し、二重管の内筒体と外筒体との間の密封空間に温度センサーを内装したことを特徴とする請求項1の、樹脂被覆式管内面補修方法。

【請求項4】外部制御装置と管路内壁補修具とを5芯コードで接続し、3線を温度センサー用として温度センサーの一端から2線他端から1線の3線コード方式で制御装置に接続し、残り2線をヒーター用としたことを特徴とする請求項1の、樹脂被覆式管内面補修方法。

【請求項5】内円筒2と外円筒3との二重円筒構造の円筒体1のの両端に円板4、4を溶接等により固定して内円筒2と外円筒3との間に環状室Cを形成し内円筒2の内心側に貫通室Dを形成し、前記円筒体1の円板4、4にゴム管体5をバンド6による緊締取付け等の固定手段により密封状態でゴム管体5を円筒体1と一体化してゴム管体5を円筒体1の外円筒3との間に加圧室Eを形成し、加圧室E内には外円筒3の外周面に巻回した加熱用ヒーター7により加圧室Eを加熱自在とし、環状室Cに温度センサー8を内装し、円板4に牽引金具9を固定して管路内壁補修具Aを構成し、

管路内壁補修具Aの温度センサー8による補修体近傍の温度を計測して加熱用ヒーター7による加熱を制御して補修体近傍の温度を所定範囲温度に維持するための制御装置を設け、

補修体の温度を所定範囲温度に維持しつつ所定時間補修体を加熱して補修体を硬化させることを特徴とする樹脂被覆式管内面補修装置。

## 【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明は、外面からの点検修理が困難な小口径の下水道管やその他の地中管に発生した破損、亀裂や接合不良等の補修を管路内面から樹脂被覆修理する技術に関するものである。

【0002】

【従来技術】この種の管路内面から樹脂被覆修理の技術に関し、特開平3-178425号「管内面の硬質チューブラーニング工法」が公知である。

【0003】

【発明が解決しようとする課題】上記の公知技術は、管路内に樹脂チューブ挿入し加圧膨張させて管路内面に圧着し加熱硬化し補修するもので、管路内全体を補修するには適するものであるが、限定された局所の補修には経済的に適切でない問題点がある。また、下水道管は種々条件の異なる箇所に埋設されていることで、補修箇所の管路周囲の地中温度は変化するとともに、加圧補修装置に装備されているゴム管体の劣化を防ぐべく温度上昇を一定限度以下にする必要があるため、補修箇所の温度を一定範囲に維持することの課題がある。

【0004】

【課題を解決するための手段】本発明は、管路内の破損箇所の樹脂被覆を行う樹脂被覆式管内面補修作業にあたり、加圧空気の供給により拡大してその周囲が管路内面に圧着させ得るゴム管体と、該ゴム管体を加熱するためのヒーターおよび温度センサーを装備し、管路内を移動自在である管路内壁補修具を使用するもので、前記管路内壁補修具のゴム管体の外周面に補修体を取付けたのち、管路内を移動するテレビカメラの誘導でワイヤー牽引により管路内の破損箇所へ管路内壁補修具を移動させたのち、ゴム管体に加圧空気を供給してゴム管体を膨張させて、ゴム管体の外周面を破損箇所の管路内壁に圧接させて、補修体を所望の補修箇所の管路内壁に圧接させ、ゴム管体の補修体近傍の温度を計測して制御装置に入力して線状ヒーターによるゴム管体の加熱を制御して補修体の温度を所定範囲温度に維持しつつ所定時間補修体を加熱することにより、補修体を所望の補修箇所の管路内壁に圧接した状態で硬化させて、樹脂被覆式管内面補修作業を完了するものである。

【0005】

【実施例】以下、図面を参照して本発明の実施例を説明する。図2は、本発明の実施にあたり使用する管路内壁補修具Aを示し、内円筒2と外円筒3との二重円筒構造の円筒体1のの両端に円板4、4を溶接等により固定して内円筒2と外円筒3との間に環状室Cを形成し内円筒2の内心側に貫通室Dを形成し、前記円筒体1の円板4、4にゴム管体5をバンド6による緊締取付け等の固定手段により密封状態でゴム管体5を円筒体1と一体化してゴム管体5を円筒体1の外円筒3との間に加圧室Eを形成し、加圧室E内には外円筒3の外周面に巻回した加熱用ヒーター7により加圧室Eを加熱自在とし、環状

室Cに温度センサー8を内装し、円板4に牽引金具9を固定して管路内壁補修具Aを構成する。

【0006】上記の管路内壁補修具Aは、牽引金具9に一端に接続したワイヤー10をウインチ等による牽引で管路内を移動自在とする。また、円板4には加圧空気供給口11が設けられており、前記加圧空気供給口11に接続したエアーホース12より加圧空気を供給することで、ゴム管体5を膨らませ加圧室Eを拡大させ、ゴム管体5を管路13の内面に圧接自在とする。管路内壁補修具Aの加熱用ヒーター7と温度センサー8は、地上の外部制御装置Bと、5芯コード14で接続し、三線を温度センサー測定用として温度センサーの一端から二線他端から1線の三線コード方式（制御装置Bと測定位置間のコードの抵抗による測定誤差を、温度センサーに接続しない一線を、温度センサーの両端に接続した二線に負荷することで防ぐ）で制御装置Bに接続し、残り二線をヒーター給電用とする。なお、実施例では、加熱ヒーターへの給電をAC100VまたはAC220V配線としたが、低電圧配線が要求される場合には、DC24V、DC12V等の他の配電方式を適用できるものである。

【0007】つぎに、本発明の実施にあたり管路内壁の補修に使用する補修材Mは、ガラス繊維やカーボン繊維を芯材に、不飽和ポリエステル樹脂、エポキシ樹脂、リポキシ樹脂のバインダーを均等に含浸してマット状とした合成樹脂製品である。補修材Mの強度や厚さは、芯材および含浸する樹脂の量により調整する。上記のマット状の補修材Mをゴム管体5の外周に巻付けるにあたり、ゴム管体5の表面には補修材Mの付着を防ぐためにグリース（油脂類）、付着防止シート等をゴム管体5と補修材Mとの間に介在させる。

【0008】ゴム管体5の外周に補修材Mを巻付けたのち、管路内壁補修具Aを管路13内に引込み、ワイヤー10をウインチ等19により牽引して不良箇所まで管路13内を移動させる。この際、管路内壁を監視するTVカメラ16からの映像信号にもとづき地上の作業監視車14内のモニターテレビ15で管路内壁の補修箇所を検知して地上の内面作業車18のウインチ等17による牽引を指示することで、管路内壁補修具Aの移動を誘導指示する。管路内壁補修具Aが所定の管路内壁不良箇所（補修箇所）で牽引され、管路内の破損箇所に補修体Mが対向したことをモニターテレビ15で確認したのち、管路内壁補修具Aの加圧室Eに加圧空気を送込む。

【0009】加圧空気の加圧室Eへの送込を継続して、ゴム管体5が管路13の内面に圧接するまで膨らませることで、補修材Mは、ゴム管体5と管路13の内面との間に押し付けられ、管路13の内面に密着する。この状態で一定時間保持すれば補修材Mは硬化するが、このとき周囲温度が低い場合は硬化時間が長くなり不安定になるので、加熱用ヒーター7で加熱し硬化の安定化と硬化時間の短縮をはかる。

【0010】温度センサー8による環状室Cの温度の計測により制御装置Bを介してで線状ヒーター7による加熱を遠隔操作して、補修体Mを所定温度範囲に維持する。所定時間の経過により補修材Mが硬化することで、補修体Mは管路内壁不良箇所（補修箇所）に密着して、本発明による管路内壁補修作業が完了する。

【0011】所定の補修箇所の補修作業の完了ののち、加熱用ヒーター7による加熱を停止するとともに、加圧室Eの加圧空気を抜きゴム管体5を収縮させゴム管体5の表面を管路13の内面より離脱させ、管路内壁補修具Aの移動を自在とする。ワイヤーをウインチ等により牽引して次の管路内壁の不良箇所まで管路内壁補修具Aの移動させて、管路内壁補修作業を継続するか、管路内壁補修具Aを地上に引上げて補修作業を完了する。管路内壁補修作業にあたり、補修材の近傍温度を最適温度範囲（例えば、20℃ないし70℃）に維持して樹脂を硬化させることで、補修箇所の管路周囲の温度に関係なく、補修材を確実に硬化させ完全な樹脂被覆補修を行うことができ、また、最高温度を規制することで、ゴム管体5のゴム劣化を防止する。

【0012】貫通室Dの存在により通水状態で補修作業を行うことができるとともに、管路周囲の地中温度の高い箇所の管路内壁補修作業にあたり、貫通室Dに冷却空気、冷却水を通過させることで、環状室C、加圧室Eの温度を下げることで（例えば20℃以下）、管路内壁補修具の移動中（補修材の管路内壁補修箇所へセット作業中）における補修材の効果を阻止することができる。管路内壁補修具は、実施例では、牽引ワイヤー方式で移動させたが、遠隔制御の自走式（ロボット式）としてもよいものである。

【0013】

【効果】本発明は、管路内の破損箇所のみに遠隔操作で樹脂被覆することで、管路内壁の補修箇所を強固な樹脂被覆の形成で、低コストで完全な樹脂被覆補修を行うことができる。更に、最適温度範囲に維持して樹脂を硬化させることで、補修箇所の管路周囲の温度に関係なく、補修材を確実に硬化させ完全な樹脂被覆補修を行うことができ、また、加圧室の最高温度を規制することで、ゴム管体のゴムの劣化を防ぎ、管路内壁補修具を半永久的に使用可能とする効果がある。

【図面の簡単な説明】

【図1】本発明による管路内壁補修作業の説明図

【図2】管路内壁補修具の縦断面図で、左半図はゴム管体を加圧しない状態、右半図はゴム管体を加圧する状態を示す。

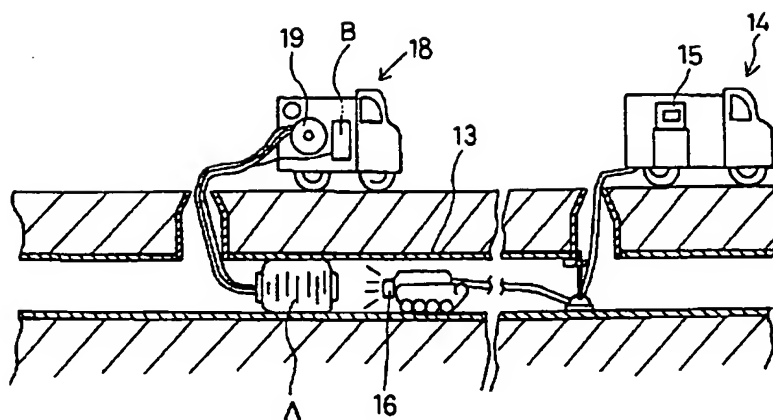
A	管路内壁補修具	B	制御装置	C	
	環状室				
D	貫通室	E	加圧室	M	
	補修材				
50	1 円筒体	2	内円筒	3	

(4)

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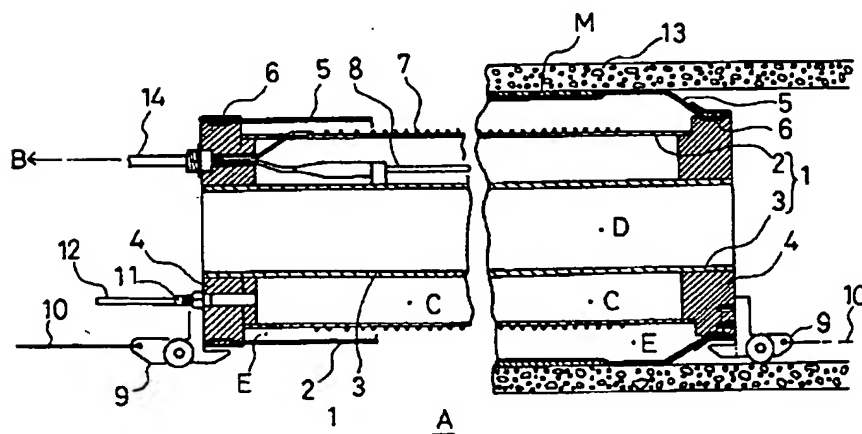
5 6  
 外円筒 加熱用ヒーター  
 4 円板 5 ゴム管体 7 8 温度センサー 13 管路

【図1】



A	管路内置補修具	B	制御装置	C	箱状部
D	貫通室	E	加圧室	M	補修材
1	円筒体	2	内円筒	3	外円筒
4	円板	5	ゴム管体	7	加熱用ヒーター
8	温度センサー	13	管路		

【図2】



(19)



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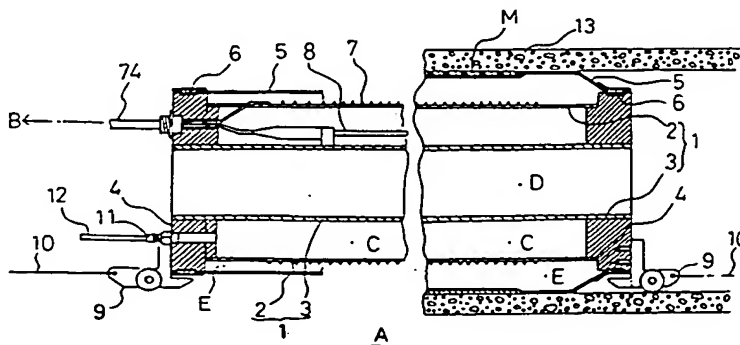
(54) Method and apparatus for repairing the pipe inner surface by resin coating.

(57) This invention relates to a method and an apparatus for repairing the pipe inner surface by resin coating.

A pipeline inner wall repair device (A) is movable in the pipeline (13) and has a rubber tubular body (5) which is expanded by supply of compressed air and is pressed against the inner surface of pipeline (13), a heater (7) for heating said rubber tubular body (5) and a thermo-sensor (8). After a mending material (M) is attached to the outer circumferential surface of the rubber tubular body (5), the repair device (A) is moved to a broken part in the pipeline (13) by hauling a wire (10) through guidance by a television camera (16) moving in the pipeline (13), the rubber

tubular body (5) is expanded by supply of compressed air thereto and presses its outer circumferential surface against the inner wall of pipeline, whereby the mending material (M) is pressed against the broken part of pipeline (13) and the outer circumferential surface of the rubber tubular body (5). The ambient temperature of the mending material is measured and inputted in the control unit (B), temperature of the mending material (M) is maintained at a specified temperature range by controlling heating by the heater (7) and the mending material (M) is heated for a specified period of time to harden. Thus, the inner surface of pipeline (13) is repaired by resin coating.

FIG. 1



## BACKGROUND OF THE INVENTION

### 1. Field of the invention:

This invention relates to a technique of repairing the internal defects, such as breaks, cracks, connecting deficiencies, etc. of small-bore sewer pipes and other underground pipes that are difficult to inspect or repair from outside by coating the defective pipe inside wall with resin.

### 2. Description of the prior art:

Regarding the technique of repairing the pipe interior by coating with resin, there has been known "The method of lining the pipe inside surface with a hard tube" (Japanese Patent Application Laying Open Gazette No.3-178425). According to this method, a resin tube is inserted into the pipeline and is pressurized to expand and press against the inside wall of pipeline. Then, the resin tube is heated to harden and thus the inner surface of pipeline is coated with a resin tube.

Although the above known technique is suitable for repairing the entire inner wall of pipeline, there is the problem that it is not economical for repairing the limited part of pipeline.

Apart from the above, since sewer pipes are embedded in places of different conditions, underground temperatures around pipelines to be repaired vary and also as it is required to keep the temperature rise within the specified limits so as to prevent degradation of a rubber tubular body provided in a pressurizing type repairing apparatus, it is desired to keep the temperature of a part to be repaired within the specified range.

## SUMMARY OF THE INVENTION

### 1. Object of the invention:

The first and the second inventions of the present application have for their object to make it possible to coat with resin a limited part of the inner wall of pipeline economically and to keep the temperature of a part to be repaired within the specified range.

In the above first and second inventions, a heater for heating the rubber tubular body is provided as a heating structure for a mending material which is pressed against the inner wall of pipeline, but the third and the fourth inventions of the present application have for their object to simplify the above heating structure for a mending material and to enhance heating efficiency.

The fifth and the sixth inventions of the present application have for their object to make it possible to select and limit freely the position of resin coat-

ing repair of pipeline inner wall with a mending material in circumferential direction of pipeline in the above first to fourth inventions.

The seventh invention of the present application has for its object to apply the sixth invention of the present application to a repair part of the pipeline inner surface at a connection between a main pipe and a branch pipe, namely, to press a mending material securely and strongly against the pipeline inner wall at a connection between a main pipe and a branch pipe, thereby resin-coating perfectly the pipeline inner wall at the connection.

In the above seventh invention, by bulging of the rubber tubular body into a branch pipeline, a deformed area of a mending material is projected toward the side of the branch pipeline and the mending material is pressed in crooked state against the inner wall of pipeline at a connection between the main pipe and the branch pipe for resin-coating. Therefore, there is the problem that residual distortion is caused in the rubber tubular body and durability of the rubber tubular body lowers.

In view of the above problem, the eighth invention of the present application has for its object to reduce residual distortion caused by bulging deformation of the rubber tubular body corresponding to the deformed area of a mending material.

### 2. Means of attaining the above object:

The first invention of the present application comprises a pipeline inner wall repair device A which includes a cylindrical body 1 of double cylindrical structure having an inner tube 2 and an outer tube 3, an annular chamber C formed between the inner tube 2 and the outer tube 3 with discs 4 fixed to both ends of the cylindrical body 1, a through-chamber D formed at the inner center of the cylindrical body 1, a rubber tubular body 5 united with the cylindrical body 1 by a band 6 or other means, a pressurizing chamber E formed between the rubber tubular body 5 and the cylindrical body 1, a heater 7 wound around the outer circumferential surface of the outer tube 3 for heating the pressurizing chamber E, a thermo-sensor 8 provided in the annular chamber C and a hauling fitting 9 fixed to the disc 4 and a control unit for maintaining the ambient temperature of a mending material at the temperature of a specified range by measuring the ambient temperature of the mending material by the thermo-sensor 8 and by controlling the heating by the heater 7. By the above control unit, the mending material is hardened by heating it for a specified period of time while keeping its temperature at a specified temperature range.

In the second invention, a pipeline inner wall repair device is movable in the pipeline and has a

rubber tubular body which is expanded by supply of compressed air and is pressed against the inner surface of pipeline, a heater for heating said rubber tubular body and a thermo-sensor. After a mending material is attached to the outer circumferential surface of the rubber tubular body, the repair device is moved to a broken part in the pipeline by hauling a wire through guidance from a television camera moving in the pipeline, the rubber tubular body is expanded by supply of compressed air thereto and presses its outer circumferential surface against the inner wall of pipeline, whereby the mending material is pressed against the broken part of pipeline and the outer circumferential surface of the rubber tubular body. The ambient temperature of the mending material is measured and inputted in the control unit, temperature of the mending material is maintained at a specified temperature range by controlling heating by the heater and the mending material is heated for a specified period of time to harden. Thus, the inner surface of pipeline is repaired by resin coating.

In the third invention, heating of the mending material is done by a surface heating body embedded in the mending material.

In the fourth invention, the mending material is heated directly by supply of electricity to the surface heating body embedded in the mending material and the surface heating body is left in the repaired part as it is embedded in the mending material.

In the fifth invention, the cylindrical body and the rubber tubular body of the pipeline inner wall repair device (in the first invention) are made rotatable freely in the pipeline by remote control.

In the sixth invention, by rotation of the cylindrical body and the rubber tubular body of the pipeline inner wall repair device (in the second and the fourth inventions) in the pipeline by remote control, the centre position of the mending material can be selected freely in circumferential direction of pipeline.

In the seventh invention, the mending material with a deformed area for resin coating by pressing against the inner wall of pipeline, according to the sixth invention, is used. The deformed area of the mending material is moved to the position opposing the branch pipe by rotating the rubber tubular body so as to project the deformed area of the mending material toward the side of branch pipeline and to press the mending material in crooked state against the inner wall of pipeline at a connection between the main pipe and the branch pipe for resin coating.

In the eighth invention, prior to the movement of the pipeline repair portion, a protector of knit structure is wound around the rubber tubular body and inflating deformation of the rubber tubular body

corresponding to the deformed area of the mending material is restricted to a specific limit.

### 3. Advantageous effect of the invention:

The first invention and the second invention of the present application produce such advantageous effect that a perfect resin-coating repair can be carried out at low cost by resin-coating only a broken portion in the pipeline by remote control and also by hardening a mending material securely, regardless of the ambient temperature of the repair portion of pipeline, while maintaining the mending material at the optimum temperature range. Moreover, by controlling the maximum temperature of a pressuring chamber, degradation of rubber of the rubber tubular body can be prevented and the pipeline inner wall repair device can be used semi-permanently.

The third and the fourth inventions of the present application produce such advantageous effect that heating efficiency can be enhanced by heating the mending material directly through applying electricity to a surface heating body embedded in the mending material. Also, strength of the mending material is enhanced by the surface heating body embedded in the mending material being left within the mending material at the repaired portion and therefore perfect resin-coating repair is done.

The fifth and the sixth inventions of the present application produce such advantageous effect that resin-coating repair portion of the inner surface of pipeline can be limited and selected in the circumferential direction of pipeline by rotating a cylindrical body and a rubber tubular body of the pipeline inner wall repair device in the pipeline through remote-control.

The seventh invention of the present application produces such advantageous effect that perfect resin-coating repair of a connection between a main pipe and a branch pipe can be done by resin-coating the pipeline inner wall of a connection between a main pipe and a branch pipe with a curved mending material having a deformed area which is bent to the branch pipe side at the connection and presses against the pipeline inner wall of the branch pipe.

The invention of the present application produces such advantageous effect that by controlling the bulging deformation of a rubber tubular body opposing a deformed area of a mending material to a specified limit, repair work efficiency is stabilized, residual distortion of the rubber tubular body is reduced, durability of the rubber tubular body is enhanced, and resin-coating repairing cost of the pipeline branch portion is reduced.

## BRIEF DESCRIPTION OF THE DRAWINGS

The nature and advantage of the present invention will be understood more clearly from the following detailed description of the invention made with reference to the accompanying drawings, in which:

Fig. 1 is a longitudinal section of a pipeline inner wall repair device, showing an embodiment of the first invention of the present application, in which the left-hand portion shows the state where a rubber tubular body is not pressurized and the right-hand portion shows the state where a rubber tubular body is pressurized.

Fig. 2 is a longitudinal section of a pipeline in lengthwise direction, illustrating the pipeline inner wall repairing work according to the second invention of the present application.

Fig. 3 is a longitudinal section of a pipeline inner wall repair device of the second invention of the present application.

Fig. 4 is a plan view of a mending material to be used for the fourth invention of the present application.

Fig. 5 is a section of a pipeline, showing the state of the pipeline inner wall repaired according to the fourth invention of the present application, in which (a) shows the case where the width of a mending material is shorter than the inner circumferential surface length of the pipeline, (b) shows the case where the width of a mending material is almost the same as the inner circumferential length of the pipeline and (c) shows the case where the width of a mending material is longer than the inner circumferential surface length of the pipeline.

Fig. 6 shows a longitudinal section of a pipeline inner wall repair device, showing an embodiment of the fifth invention of the present application.

Fig. 7 is a longitudinal section of a part of an air supply construction of the fifth invention.

Fig. 8 is a front view of a part of the air supply construction.

Fig. 9 is a side view of a part of the air supply construction.

Fig. 10 is a plan view of a mending material to be used for the sixth invention of the present application, in which (a) shows the formation of a radial cutting-plane line, (b) shows the formation of a central through-hole and (c) shows the formation of a central through-hole and broken line parts.

Fig. 11 shows the deformation of the rubber tubular body and the mending material, in longitudinal section of the pipeline, at the pipeline inner wall repairing work according to the sixth invention of the present application, in which (a)

shows the state before deforming and (b) shows the state being deformed.

Fig. 12 shows the deformation of the rubber tubular body and the mending material, in cross section, at the pipeline inner wall repairing work according to the sixth invention of the present application, in which (a) shows the state before deforming; (b) shows the state being deformed and (c) shows the state where the repair work was finished.

Fig. 13 is a plan view of a mending material, similar to Fig. 10, showing an embodiment in which the repairing range of the pipeline inner surface is a part of the circumference of a pipeline.

Fig. 14 is a sketch showing an example of the pipeline inner wall repairing according to the combination of the sixth invention and the second invention of the present application, in which the upper (a) shows the case where the mending operation with a mending material M precedes the mending operation with a mending material N for a branch connection and the lower (b) shows the case where the mending operation with a mending material N for a branch connection precedes the mending operation with a mending material M.

Fig. 15 shows the deformation of the rubber tubular body, a protector and the mending material, in longitudinal direction of a pipeline, at the pipeline inner wall repairing work according to the seventh invention of the present application, in which (a) shows the state before deforming and (b) shows the state being deformed.

Fig. 16 shows the protector shown in Fig. 15(a), in which (a) is a developed plan view and (b) shows a longitudinal section at the center line of (a).

Fig. 17 shows the protector shown in Fig. 15(b), in which (a) is a developed plan view and (b) is a longitudinal section at the center line of (a).

Fig. 18 is another embodiment of the protector according to the seventh invention of the present application, in which (a) is a developed plan view and (b) is a vertical section at the center line of (a).

## DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

The present invention is described below with reference to the accompanying drawings.

Embodiments of the first invention and the second invention are described below with reference to Fig. 1 and Fig. 2.

Fig. 1 shows a pipeline inner wall repair device A of an embodiment of the first invention of the present application. This device A comprises a



cylindrical body 1 of double cylindrical construction (an inner tube 2 and an outer tube 3), discs 4 fixed at both ends of the cylindrical body 1 by welding or other means, an annular chamber C formed between the inner tube 2 and the outer tube 3, a through-chamber D at the inner center side of the cylindrical body 1, a pressurizing chamber E formed between the outer tube 3 and a rubber tubular body 5 which is united with the cylindrical body 1, a heater 7 wound around the outer circumferential surface of the outer tube 3 for heating the pressurizing chamber E, a thermo-sensor 8 provided in the annular chamber C and a hauling fitting 9 fixed to the disc 4.

In the above embodiment, the thermo-sensor 8 is provided in the annular chamber C but can be fixed in the inner tube 2 or can be provided in the pressurizing chamber E for sensing the temperature of a mending material M by measuring the temperature of the inner tube 2 or the pressuring chamber E. It is also possible to fix the thermo-sensor 8 at the inner surface side of the rubber tubular body 5 which makes contact with the mending material M for measuring the temperature of the mending material M through the medium of the rubber tubular body 5.

The above pipeline inner wall repair device A can be moved freely in the pipeline by hauling a wire 10 by a winch or other means. One end of the wire 10 is connected to a hauling fitting 9. A compressed air supply hole 11 is provided at the disc 4 and by supplying compressed air by an air hose 12 connected to the compressed air supply hole 11, the rubber tubular body 5 is expanded, whereby the pressurizing chamber E is enlarged and the rubber tubular body 5 is pressed against the inner surface of a pipeline 13.

The heater 7 and the thermo-sensor 8 of the pipeline inner wall repair device A are connected to an outside control unit B above the ground by a 5-core wire cord 14. Of the 5 core wires, three core wires are for measuring by the thermo-sensor 8 and the remaining two are for supplying electricity to the heater 7. In the embodiment, electric distribution to the heater 7 is made by AC 100V or AC 220V wiring but in the case where low voltage wiring is required, other electric distribution systems, such as DC 24V, DC 12V, etc. can be applied.

The mending material M to be used for mending the pipeline inner wall, when working the invention, is a synthetic resin mat obtained by soaking core material of glass or carbon fibers uniformly in a binder of unsaturated polyester resin, epoxy resin or lipoxy resin. The strength and thickness of the mending material M is adjusted by varying the amount of the core material and the binder resin used.

In repairing the pipeline inner wall according to the second invention of the present application, the mending material for a branch connection part M (in mat state) is wrapped around the outer circumference of the rubber tubular body 5. In order to prevent the mending material for a branch connection part from adhering to the surface of the rubber tubular body 5, grease (oil) or adhesion preventive sheet is interposed between the rubber tubular body 5 and the mending material M for a branch connection part. After the mending material M for a branch connection part was rapped around the outer circumference of the rubber tubular body 5, the pipeline inner wall repair device A is inserted into the pipeline 13 and is moved in the pipeline 13 to the defective part by hauling the wire 10 by a winch 19 or some other means. At this time, the pipeline inner wall repair device A is hauled to the defective part of the pipeline inner wall (part to be repaired) by sensing the defective part by a monitor television 15 in a work monitoring car 14 above the ground on the basis of picture signals from a TV camera 16 which monitors the pipeline inner wall.

After it was confirmed by the monitor television 15 that the pipeline inner wall repair device A was hauled to the pipeline inner wall defective portion (part to be repaired) and the mending material M opposed the broken part in the pipeline, compressed air is sent into the pressuring chamber E of the pipeline inner wall repair device A.

Supply of compressed air to the pressurizing chamber E is continued until the rubber tubular body 5 is pressed against the inner surface of the pipeline 13, whereby the mending material M is pressed between the rubber tubular body 5 and the inner surface of the pipeline 13 and sticks fast to the inner surface of the pipeline 13. If this state is maintained for a specified period of time, the mending material M hardens but if the ambient temperature is low, hardening requires a longer time and becomes unstable. Therefore, heating by the heater 7 is carried out to stabilize hardening and shorten the hardening time. The mending material M is maintained at the temperature of the specified range by remote-controlling the heating by the heater 7, through the medium of the control unit B, after measuring the temperature of the annular chamber C (or the rubber tubular body 5, the mending material M, etc.) by the thermo-sensor 8. When the mending material M hardens with the lapse of the specified time, it sticks fast to the pipeline inner wall defective part (part to be repaired) and thus the pipeline inner wall repairing work according to the first invention of the present application is completed.

After the repairing work of the part to be repaired was completed, electric supply to the heater

7 is stopped and compressed air is let out of the pressurizing chamber E, whereby the rubber tubular body 5 shrinks and the surface of the rubber tubular body 5 is separated from the inner surface of the pipeline 13. Thus, the pipeline inner wall repair device A is made movable. Then, the pipeline inner wall repair device A is moved to the next defective part of the pipeline inner wall by hauling the wire by a winch or the like for continuing the pipeline inner wall repairing work or the pipeline inner wall repair device A is pulled up to the ground to finish the repairing work.

At the pipeline inner wall repairing work, the mending material M can be hardened securely and perfect resin-coating mending can be carried out, regardless of the temperature around the defective part of the pipeline, by hardening resin while keeping the ambient temperature of the mending material M at the optimum temperature. Also, rubber degradation of the rubber tubular body 5 can be prevented by regulating the optimum temperature.

The existence of the through-chamber D enables us to carry out the repairing work in water running through state and also enables us to check hardening of the mending material while the pipeline inner wall repair device is being moved (while the mending material is being set to the repair part of the pipeline inner wall).

In the embodiment, the pipeline inner wall repair device is moved by the hauling wire system but can be moved by the remote-controlled self-running system (robot system).

The third invention and the fourth invention of the present application are described below, with reference to Figs. 3, 4 and 5.

In the first and the second inventions mentioned above, the pressurizing chamber E is heated by the heater wrapped around the outer circumference of the outer tube 3 but instead of the heater provided in the pressurizing chamber E, the mending material M is provided at its inner surface with a surface heating body 7a, as shown in Fig. 4.

Referring to Fig. 3, in the pipeline inner wall repair device A of an embodiment of the third invention a connection terminal 29 which is connectable to a connection plug 74 of the surface heating body 7a of the mending material M is fixed to the outer surface of an end of the rubber tubular body 5 so as to supply electricity to the surface heating body 7a provided in the mending material M.

The above connection terminal 29 of the pipeline inner wall repair device A is connected, together with the thermo-sensor 8, to the outside control unit B above the ground through the medium of the 5-core wire cord 14 and thus the surface heating body 7a is supplied with electricity under the control by the control unit B.

Fig. 4 shows the embodiment of the surface heating body 7a. The surface heating body 7a which is like a heater used for a hot carpet, a floor heating mat, etc. is coated at its surface and back with a mending material M, namely, the surface heating body 7a is in the state of being embedded in the mending material M. A plug 74 to be connected to the connection terminal 29 of the pipeline inner wall repair device A is protruded from an end of the mending material M and a heater wire 71 is connected to the plug 74 by a lead wire 73. The surface heating body 7a is made of woven fabric of thread-like heater wire 71 and weft yarn. It is bendable and foldable.

In the repair work of the pipeline inner wall according to the fourth invention, action and effect which are different from those of the second invention are obtained by stabilizing hardening and shortening hardening time of the mending material M by heating the mending material M through supply of electricity to the surface heating body 7a. However, movement of the pipeline inner wall repair device A and other operations of the pipeline inner wall repair device A, such as supply of compressed air to the pressurizing chamber E, adhering the mending material M to the inner surface of the pipeline, etc. are the same as in the case of the first invention.

The mending material M is kept within the range of the specified temperature by remote-controlling the heating by the surface heating body 7a through the medium of the control unit B, while measuring the temperatures of the annular chamber C, the rubber tubular body 5, the mending material M, etc. by the thermo-sensor 8.

When the mending material M hardens with the lapse of the specified time, the mending material M sticks fast to the defective portion (portion to be repaired) of the pipeline inner wall and thus the repairing work of the pipeline inner wall according to the third invention is completed.

After the repair work of the pipeline inner wall was completed, the pipeline inner wall repair device A is moved from the repaired portion, whereupon the connection plug 28 of the mending material M comes off the connection terminal 29 of the pipeline inner wall repair device A and both the surface heating body 7a and the mending material M remain as they are stuck to the repaired portion of the pipeline inner wall. Depending upon the relation between the diameter of the pipeline inner wall repaired portion and the width of the mending material M, repaired state of the pipeline inner wall varies as shown by Fig. 5(a), (b) and (c), but in any case the surface heating body 7a is always enclosed with the mending material M and is not exposed. Therefore, a repaired portion of the pipeline inner wall is completely coated with resin by

the mending material M and the function as pipeline is not hindered. Moreover, strength of the mending material M is increased by unification of the surface heating body 7a with the mending material M.

The sixth invention is the same as the second invention or the fourth invention in that the pipeline inner wall repair device A is moved in lengthwise direction of the pipeline to the desired repair portion in the pipeline and the mending material M is heated by electricity supply to the heater 7 or the surface heating body 7a, but according to the sixth invention, when the pipeline inner wall repair device A was moved in lengthwise direction of the pipeline to the desired repair portion in the pipeline, the cylindrical body 1, the rubber tubular body 5 united with the cylindrical body 1 and the mending material M are turned in circumferential direction of pipeline to locate the center of the mending material M at a repair portion in circumferential direction of pipeline by electricity supply to the motor 25 on the basis of control by the control unit B on the ground.

The seventh invention of the present application is described below, with reference to Fig. 10 - Fig. 14.

Repair of the pipeline inner wall according to the seventh invention is applied to a connection part of branch pipe, namely, breakage, cracks, etc. at a connection part between a main pipe and a branch pipe are repaired by resin coating of the inner surface of pipeline.

Fig. 10 shows a mending material N for a branch connection part to be used in carrying out the seventh invention. The mending material N is different from the mending material M (used for the second invention, the fourth invention and the sixth invention) in that it has a deformed area at its central part but the composition as mending material is not different.

In the embodiment of Fig. 10(a), a deformed area 20 comprises a plurality of cutting-plane lines 31 which make it possible to fold the center part of the mending material N for a branch connection part to the front side or the rear side.

In the embodiment of Fig. 10(b), the deformed area 20 has a central through-hole 32 and a thin or soft deformed part 33 around the through-hole 32.

In the embodiment of Fig. 10(c), the deformed area 20 has a central through-hole 32 and a plurality of thin and soft broken lines 34 around the circumference of the through-hole in radial direction.

In working the seventh invention of the present application, the pipeline inner wall repair device A to be used for the fifth invention is used. The cylindrical body 1, the rubber tubular body 5 and the mending material N are turned freely by re-

mote-control operation and a repair portion of the inner surface of pipeline is made selective in circumferential direction of the pipeline. A mending material N for a branch connection having a deformed area 20 is mounted on the rubber tubular body 5 of the pipeline inner wall repair device A.

As in the case of the second invention, the pipeline inner wall repair device A provided with the mending material N for a branch connection is moved to a repair portion (branch pipe connection part) by travelling means of remote control, such as a hauling wire system, a self-travelling by remote control (robot system).

A monitor television 26 is inserted into a branch pipe 25 at a branch pipe connection part (repair part). (Refer to Fig. 11(a)).

The cylindrical body 1 of the pipeline inner wall repair device A is turned by supplying electricity to the motor, while confirming by sight that the surface of the mending material N opposes the end portion of the branch pipe 25 by the monitor television 26 and the deformed area 20 of the mending material N is located oppositely to the branch pipe 25. (Refer to Fig.12(a) ).

After it was confirmed by the monitor television 26 that the deformed area of the mending material N opposed the broken part of the branch pipe 25 at the branch pipe connection part, compressed air is supplied into the pressurizing chamber E of the pipeline inner wall repair device A.

Supply of compressed air to the pressurizing chamber E is continued until the rubber tubular body 5 presses against the inner surface of the pipeline 13. Further supply of compressed air to the pressurizing chamber E makes the rubber tubular body 5 opposite to the branch pipe 25 project into the branch pipe 25. By this projection of the rubber tubular body 5 into the branch pipe 25, the deformed part 20 of the mending material N is pushed into the branch pipe 25 and is deformed, whereby the central part of the deformed part 20 is opened (or the central through-hole 32 is enlarged) and the circumferential part of the deformed part 20 bends as if it opposed the branch pipe 25 (refer to Fig. 11(b) and Fig. 12(b) ).

Further supply of compressed air into the pressurizing chamber E increases the amount of projection of the rubber tubular body 5 into the branch pipe 25 and consequently increases the bending of the deformed part 20 of the mending material N toward the side of the branch pipe 25. Finally, the deformed part 20 of the mending material N is pressed between the rubber tubular body 5 and the inner surface of the branch pipe 25 and sticks fast to the inner surface of the branch pipe 25 (refer to Fig.12(c) ).

Since the repair of the pipeline inner wall according to the seventh invention is applied to the

branch pipe connection part, the object of the seventh invention can be attained by using the mending material N for a branch connection part shown in Fig. 13, instead of the mending material N for a branch connection part shown in Fig. 10, and by making the repairing range of the inner surface of pipeline a part of the circumference of pipeline.

The connection of the mending material M according to the sixth invention to the mending material N according to the second invention and the fourth invention can be set up arbitrarily but Fig. 14 shows the case where both mending materials M, N are overlapped. Fig. 14(a) shows that the repairing operation with the mending material N for a branch connection part is preceded by the repairing operation with the mending material M and Fig. 14(b) shows that the repairing operation with the mending material M for a branch connection part is preceded by the repairing operation with the mending material N.

The eighth invention of the present application comprises the steps of mounting a cylindrical or sheet-like protector P of knit structure on the outer circumferential surface of the rubber tubular body 5 of the pipeline inner wall repair device A, interposing the protector P between the mending material M for resin coating and the rubber tubular body 5, drawing the pipeline inner wall repair device A into the pipeline and moving it to a repair portion in the pipeline. Operations thereafter are the same as in the case of each invention mentioned before. (Refer to Fig. 15).

The protector P has knit structure based on the knitting design in which extension of the rubber tubular body 5 in lengthwise direction and in diametrical direction suitable for the bulging control measurements which control the bulging limit of the rubber tubular body 5 is calculated thoroughly. An example is shown below.

Material:

Nylon 100%

Structure:

Smooth knit of cylindrical shape and 38cm in diameter. (two-ply yarn of nylon 70-denier is used)

Metsuke (weight per unit area):  
200g/m<sup>2</sup>

If the protector P is made in cylindrical shape slightly smaller than the outer shape of the rubber tubular body 5 and is made elastically contractile, the protector P will have better adhesion to the outer circumferential surface of the rubber tubular body 5 and detaching from/attaching to the rubber tubular body 5 is easier. Also, when the pipeline inner wall repair device A is moved after the repairing work with the mending material M was finished, the protector P moves as it sticks fast to the rubber tubular body 5. Thus, detaching from the mending

material M united with the inner surface of pipeline wall is done accurately and easily.

Fig. 16 shows the protector in developed flat shape when the rubber tubular body 5 does not bulge partially as yet. As shown in Fig. 17, due to partial bulging of the rubber tubular body 5, a partially bulging part of the rubber tubular body 5 varies from P<sub>1</sub> to P<sub>2</sub>. Deformation at this time is limited by the extension margin of material and limitation on the amount of movement of material toward the central deformed part due to knit structure.

Limits on partial bulging of the rubber tubular body 5 is set by the deformation limits on the protector P.

Fig. 18 shows an embodiment in which a circumferential edge tape R is sewn to the circumference of the protector P. This checks the movement of material toward the central deformed part and also permits the deformation of the central deformed part due to extension of material.

In the fifth invention to the seventh invention, too, the position of the rubber tubular body 5 opposite to a branch pipe can be varied by turning the rubber tubular body 5 and consequently residual distortion due to partial bulging of the rubber tubular body 5 can be levelled, but in this invention residual distortion is decreased owing to the existence of the protector P and durability of the rubber tubular body 5 is increased. In the embodiment, residual distortion of the rubber tubular body 5 is 1.0003 times as against 1.0467 times in the case where the protector does not exist and the section of the bulging part shows equal thickness.

## Claims

1. A pipe inner surface repairing apparatus of resin-coating type which is moved in a pipeline by remote control: comprising a pipeline inner wall repair device A which includes
  - a cylindrical body 1 of double wall structure having an inner tube 2 and an outer tube 3;
  - discs 4 fixed to both ends of the cylindrical body 1 by welding or other means;
  - an annular chamber C formed between the inner tube 2 and the outer tube 3;
  - a through-chamber D formed at the inner center side of the cylindrical body 1;
  - a rubber tubular body 5 clamped to each disc 4 by a band 6 to be united with the cylindrical body 1;
  - a pressuring chamber E formed between the rubber tubular body 5 and the outer tube 3 of the cylindrical body 1, said chamber E being heated by a heater 7 wound around the outer circumferential surface of the outer tube 3;
  - a thermo-sensor 8 provided in the annular

chamber C;

a traction fitting 9 fixed to the disc 4; and  
a control unit which maintains the ambient  
temperature of a mending material at the tem-  
perature of the specified range by measuring  
the ambient temperature of the mending ma-  
terial by the thermo-sensor 8 and by control-  
ling heating by the heater 7, whereby the  
mending material is heated for a specified pe-  
riod of time to harden, while its temperature is  
maintained at the temperature of a specified  
range.

2. A method of repairing the pipe inner surface  
by resin coating by using a pipeline inner wall  
repair device which is movable in a pipeline  
and has a rubber tubular body which is ex-  
panded by supply of compressed air thereto  
and is pressed at its circumferential surface  
against the pipeline inner surface, a heater for  
heating said rubber tubular body and a  
thermo-sensor, comprising the steps of  
fitting a mending material to the outer circum-  
ferential surface of said rubber tubular body;  
moving said pipeline inner wall repair device in  
a pipeline by wire hauling to a broken part in  
the pipeline through the guidance of a televi-  
sion camera moving in the pipeline;  
supplying compressed air to the rubber tubular  
body to expand it and to press the outer cir-  
cumferential surface of the rubber tubular  
body, along with the mending material, against  
the inner wall of pipeline at the broken part;  
heating the mending material for a specified  
period of time to harden, while measuring the  
ambient temperature of the mending material  
on said pipeline inner wall repair device and  
inputting measured temperatures in said con-  
trol unit so as to control heating by the heater  
and maintain the mending material tempera-  
ture at the temperature within the specified  
range.
3. The method of repairing the pipe inner surface  
by resin coating as defined in Claim 2, wherein  
an outside control unit is connected to the  
pipeline inner wall repair device by a cord with  
5 core wires, of which three wires are for  
connecting the thermo-sensor to the control  
unit and the remaining two wires are for the  
heater.
4. A pipe inner surface repairing apparatus of  
resin coating type, whereby when a broken  
part in a pipeline is repaired by resin coating, a  
pipeline inner wall repair device having a rub-  
ber tubular body which expands by supply of  
compressed air thereto and presses at its cir-

cumferential surface against the pipeline inner  
surface and is fitted at its outer circumferential  
surface with a mending material is moved free-  
ly in a pipeline and the mending material is  
hardened by heating as it is pressed against  
the inner wall of pipeline at a repairing part or  
a broken part for resin coating repair,  
characterized in that a surface heating body is  
embedded in the mending material and a con-  
nection terminal is exposed from an end por-  
tion of the mending material for connection of  
the surface heating body to a feed cable so  
that the mending material is heated directly by  
the surface heating body and the surface heat-  
ing body remains at the repaired part coated  
with the mending material.

5. A method of repairing the pipe inner surface of  
resin coating type, wherein at the repairing  
work of the pipe inner surface with resin coat-  
ing,  
a pipeline inner wall repair device which has a  
rubber tubular body which expands by supply  
of compressed air thereto and presses at its  
circumferential surface against the pipeline in-  
ner surface is used,  
after a mending material is fitted to the outer  
circumferential surface of the rubber tubular  
body, said pipeline inner wall repair device is  
moved to a broken part in the pipeline by the  
wire hauling through the guidance of a televi-  
sion camera moving in the pipeline, the rubber  
tubular body is expanded by supply of com-  
pressed air thereto and the outer circumferen-  
tial surface of the rubber tubular body, along  
with the mending material, is pressed against  
the pipeline inner wall at the broken part, and  
the mending material is hardened as it is  
pressed against the pipeline inner wall at the  
desired repairing part by heating the mending  
material for a specified period of time and thus  
the repairing work is finished,  
characterized in that  
the mending material in which a surface heat-  
ing body which is connected to a feed cable  
through the medium of a connection terminal  
exposed from an end portion of the mending  
material is embedded is fixed to the outer  
circumferential surface of the rubber tubular  
body of said pipeline inner wall repair device,  
the mending material is pressed against the  
pipeline inner wall at the desired repairing part  
by movement of said pipeline inner wall repair  
device and by expansion of the rubber tubular  
body due to supply of compressed air to the  
rubber tubular body,  
the mending material is heated as it is pressed  
against the pipeline inner wall at the desired

repairing part by supplying electricity to the surface heating body through the medium of a feed cable,

after the mending material was hardened by heating, the pipeline inner wall repair device is removed from the repaired part by releasing the connection between the feed cable and the surface heating body, and the surface heating body remains at the repaired part as it is embedded in the hardened mending material.

6. A pipe inner surface repairing apparatus of resin coating type, whereby when a broken part in a pipeline is repaired by resin coating, a pipeline inner wall repair device having a rubber tubular body which expands by supply of compressed air thereto and presses at its circumferential surface against the pipeline inner surface and is fitted at its outer circumferential surface with a mending material is moved freely in a pipeline and the mending material is hardened by heating as it is pressed against the inner wall of pipeline at a repairing part or a broken part for resin coating repair, characterized in that a cylindrical body provided with a rubber tubular body in the pipeline inner wall repair device is rotatable in the pipeline by remote control.

7. A method of repairing the pipe inner surface of resin coating type, wherein at the repairing work of the pipe inner surface with resin coating, a pipeline inner wall repair device which has a rubber tubular body which expands by supply of compressed air thereto and presses at its circumferential surface against the pipeline inner surface is used, after a mending material is fitted to the outer circumferential surface of the rubber tubular body, said pipeline inner wall repair device is moved to a broken part in the pipeline by the wire hauling through the guidance of a television camera moving in the pipeline, the rubber tubular body is expanded by supply of compressed air thereto and the outer circumferential surface of the rubber tubular body, along with the mending material, is pressed against the pipeline inner wall at the broken part, and the mending material is hardened as it is pressed against the pipeline inner wall at the desired repairing part by heating the mending material for a specified period of time and thus the repairing work is finished, characterized in that a cylindrical body of the pipeline inner wall repair device is operated by remote control so that the position of the mending material fitted

to the outer circumferential surface of the rubber tubular body of the pipeline inner wall repair device in the direction of pipeline inner surface circumference is made optional.

8. A method of repairing the pipe inner surface of resin coating type, wherein at the repairing work of the pipe inner surface with resin coating, a pipeline inner wall repair device which has a rubber tubular body which expands by supply of compressed air thereto and presses at its circumferential surface against the pipeline inner surface is used, after a mending material is fitted to the outer circumferential surface of the rubber tubular body, said pipeline inner wall repair device is moved to a broken part in the pipeline by the wire hauling through the guidance of a television camera moving in the pipeline, the rubber tubular body is expanded by supply of compressed air thereto and the outer circumferential surface of the rubber tubular body, along with the mending material, is pressed against the pipeline inner wall at the broken part, and the mending material is hardened as it is pressed against the pipeline inner wall at the desired repairing part by heating the mending material for a specified period of time and thus the repairing work is finished, characterized in that in fitting a mending material to the outer circumferential surface of the rubber tubular body of said pipeline inner wall repair device, a mending material with a deformed area and a pipeline inner wall repair device which is rotatable by remote control are used, a television camera is inserted into a branch pipe and the pipeline inner wall repair device moved in the pipeline to a branch pipe connection part is rotated by remote control, while confirming the surface state of the mending material opposing the branch pipe connection part, after confirming that the mending material fitted to the outer circumferential surface of the rubber tubular body of the pipeline inner wall repair device is located opposite to the branch pipe connection part by the television camera inserted in the branch pipe, the rubber tubular body is expanded by supply of compressed air thereto, the deformed area of the mending material is protruded toward the side of the branch pipe by expansion of the rubber tubular body contacting the deformed area of the mending material and is pressed against the pipeline inner wall at a connection part between a main pipe

and a branch pipe for resin coating.

9. A method of repairing the pipe inner surface of resin coating type, wherein at the repairing work of the pipe inner surface with resin coating, 5  
a pipeline inner wall repair device which has a rubber tubular body which expands by supply of compressed air thereto and presses at its circumferential surface against the pipeline inner surface is used, 10  
after a mending material is fitted to the outer circumferential surface of the rubber tubular body, said pipeline inner wall repair device is moved to a broken part in the pipeline by the wire hauling through the guidance of a television camera moving in the pipeline, the rubber tubular body is expanded by supply of compressed air thereto and the outer circumferential surface of the rubber tubular body, along with the mending material, is pressed against the pipeline inner wall at the broken part, and the mending material is hardened as it is pressed against the pipeline inner wall at the desired repairing part by heating the mending material for a specified period of time and thus the repairing work is finished, 15  
characterized in that  
in fitting a mending material to the outer circumferential surface of the rubber tubular body of said pipeline inner wall repair device, a mending material with a deformed area and a pipeline inner wall repair device which is rotatable by remote control are used, 20  
a protector of knit structure is interposed between the mending material and the rubber tubular body, 25  
the deformed area of the mending material is protruded toward the side of the branch pipe by expansion of the rubber tubular body contacting the deformed area of the mending material and is pressed against the pipeline inner wall at a connection part between a main pipe and a branch pipe for resin coating, and the bulging deformation of the rubber tubular body opposite to the deformed area of the mending material is regulated to a specified limit by the protector of knit structure. 30  
35  
40  
45

50

55

FIG. 1

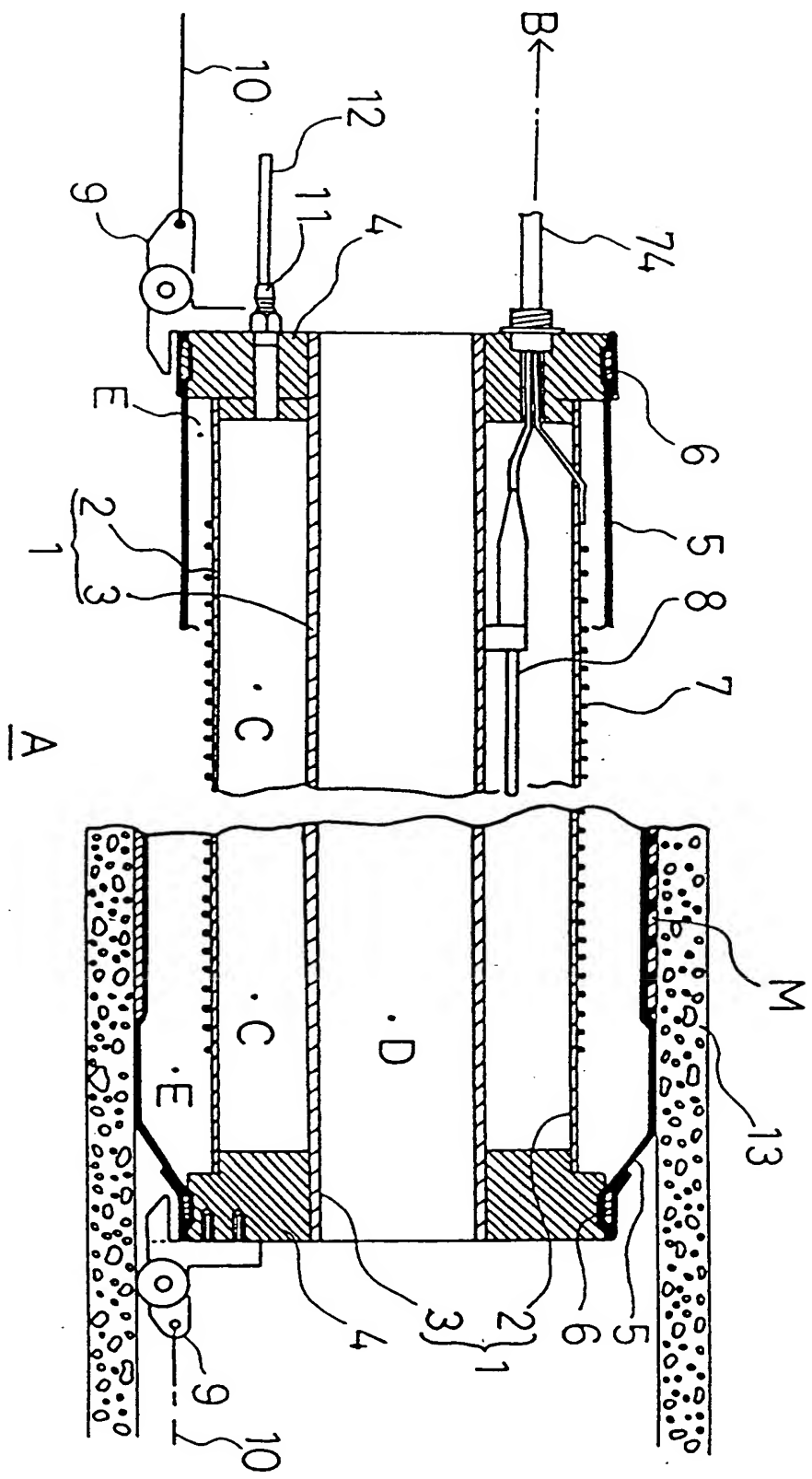




FIG. 2

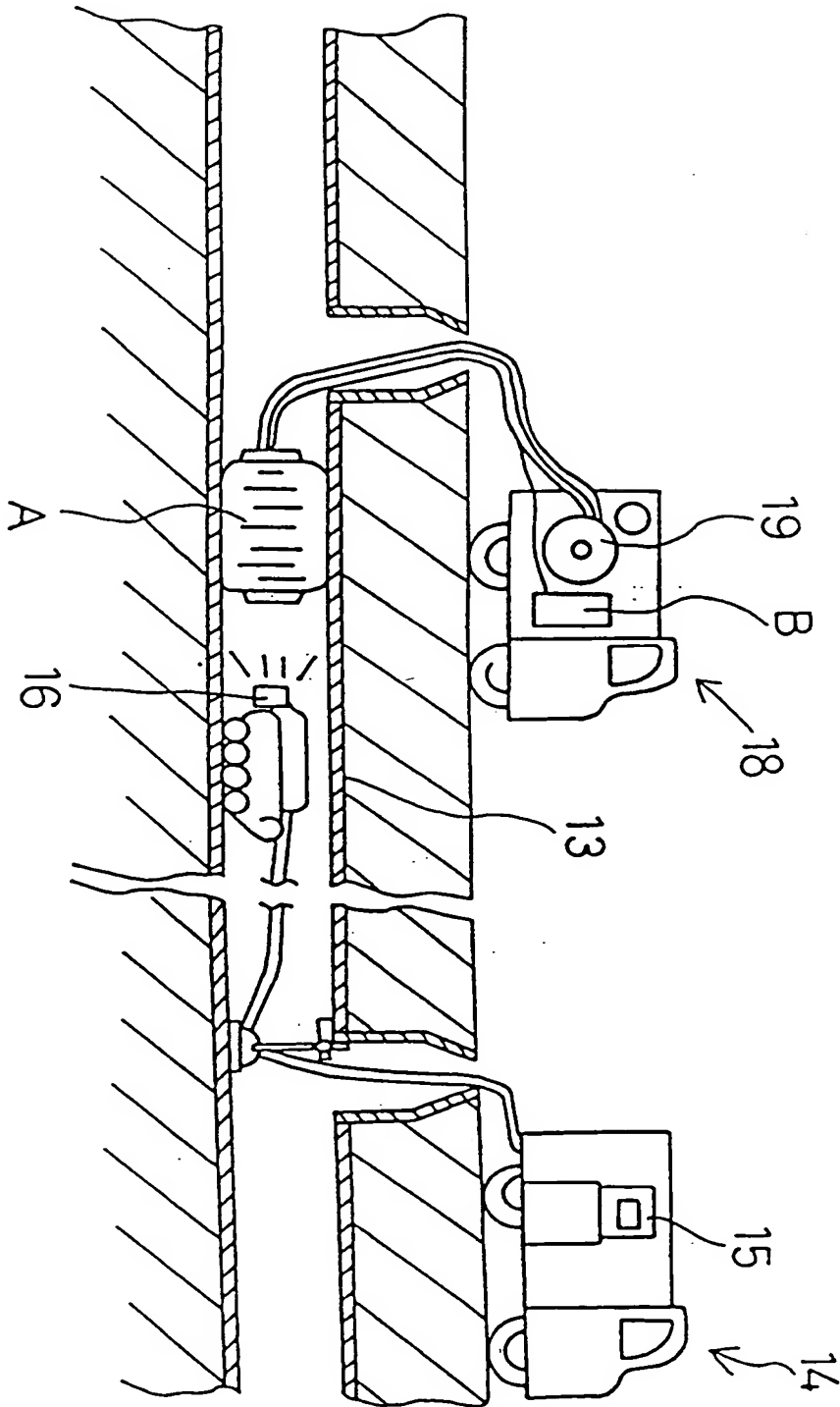


FIG 3

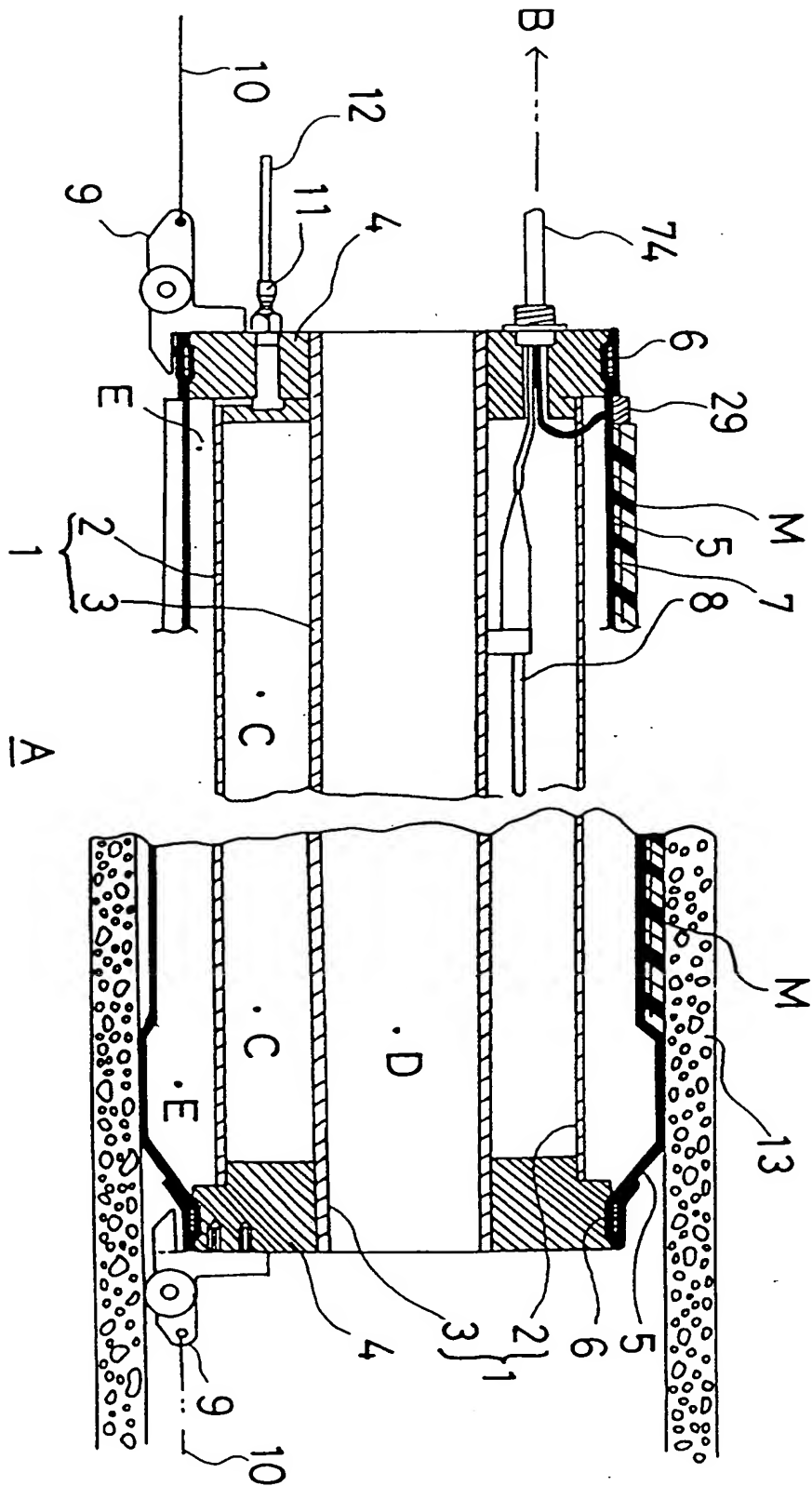


FIG 4

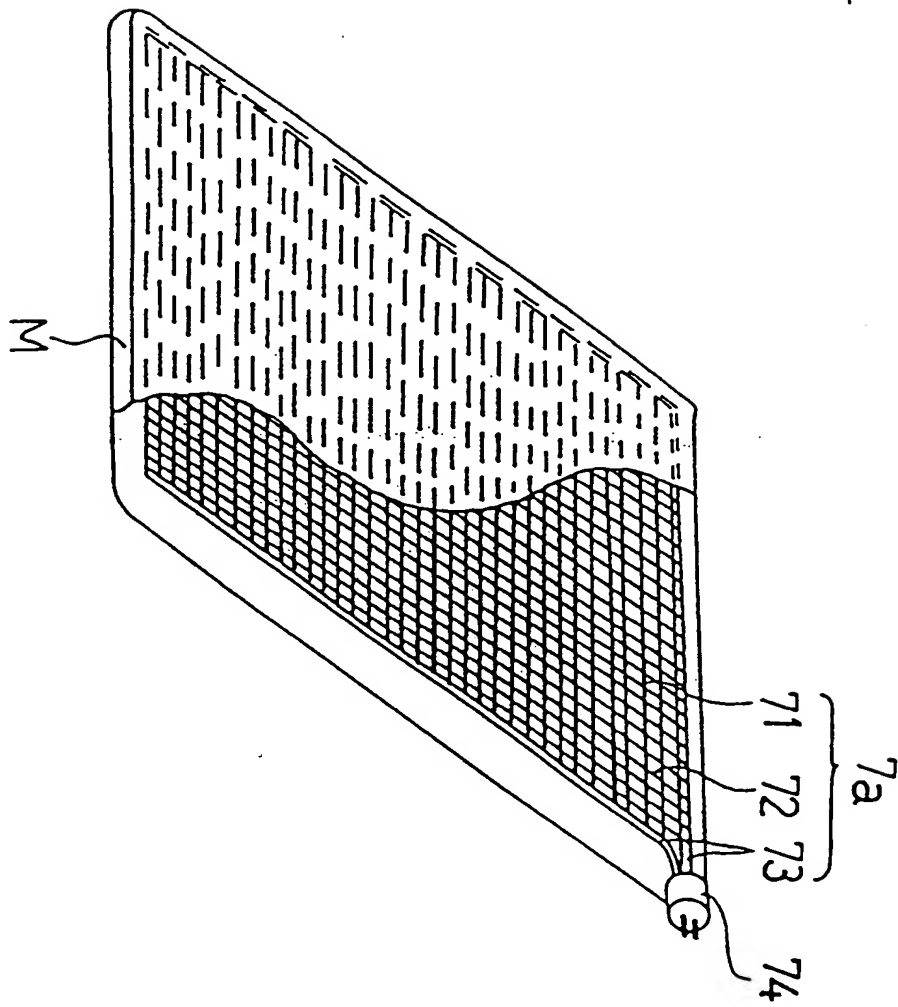


FIG 5

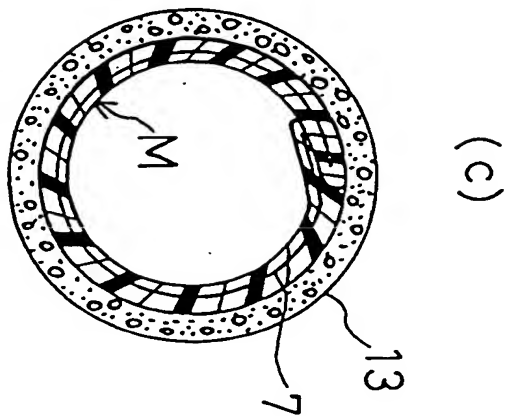
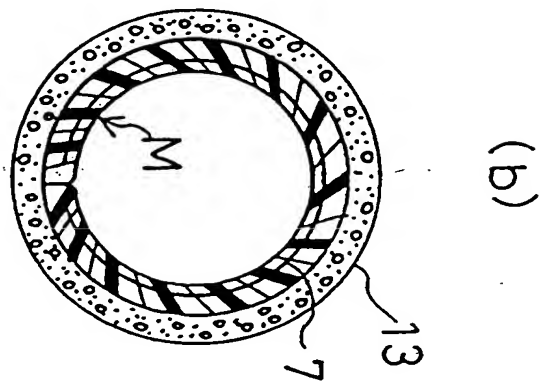
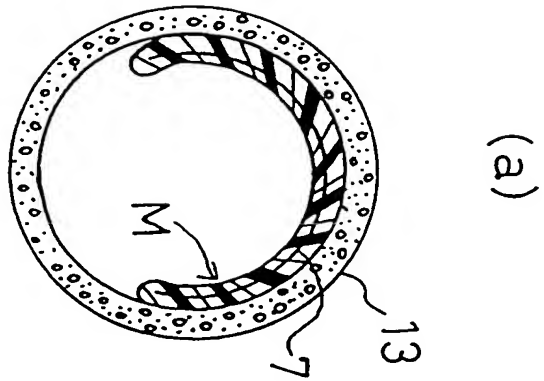


FIG 6

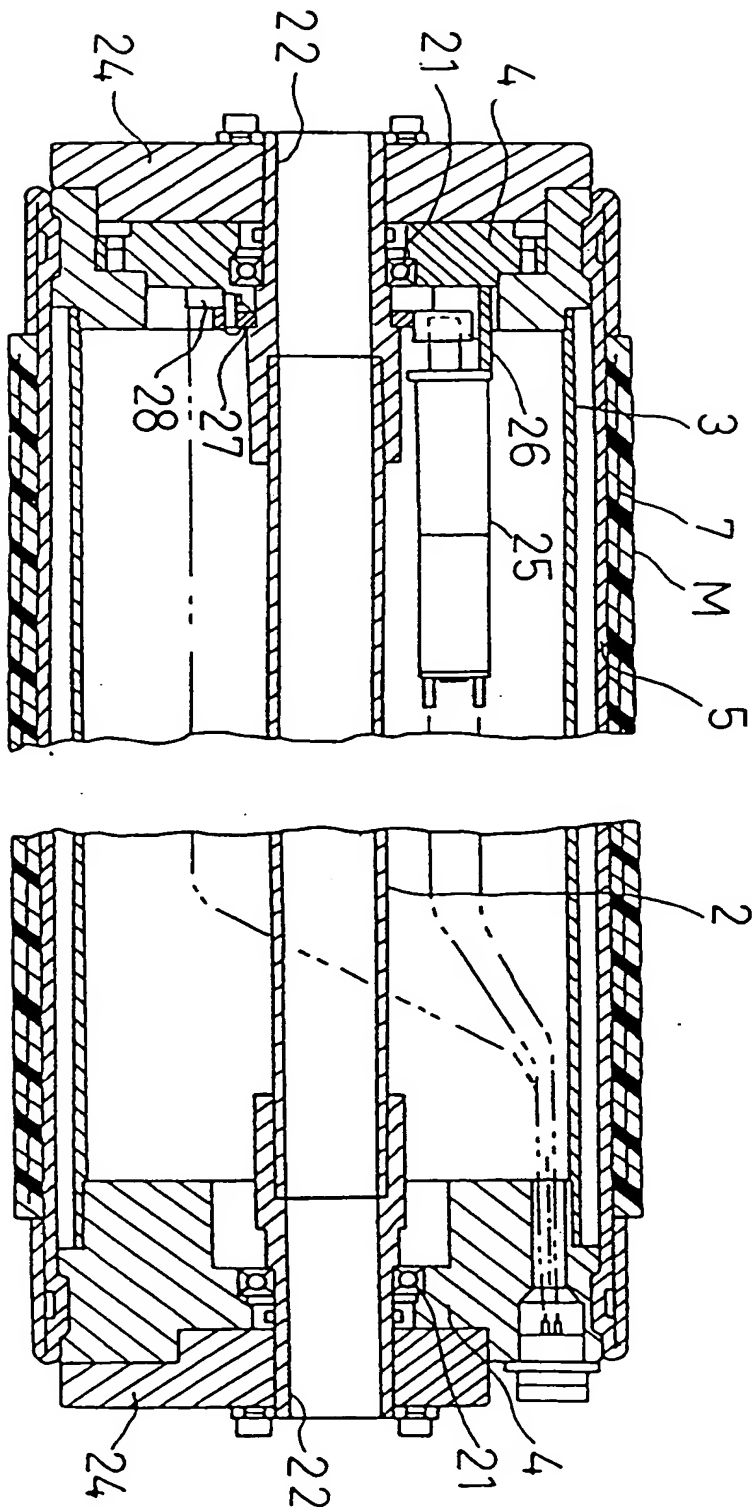


FIG 7

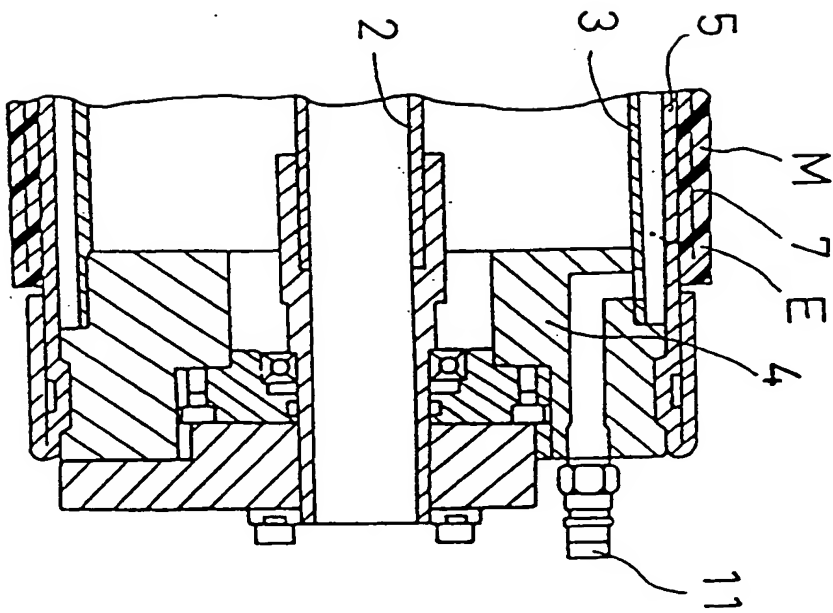


FIG 8

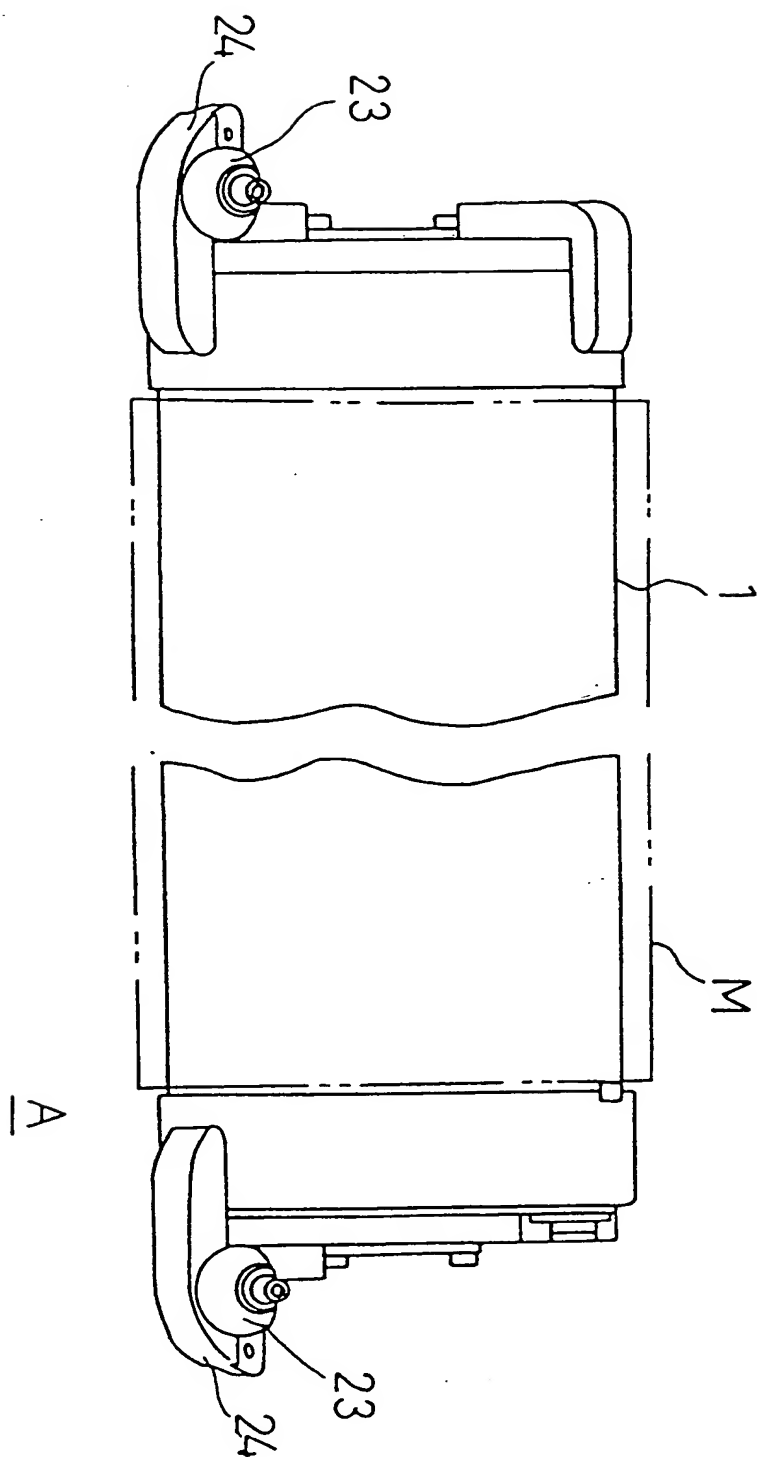


FIG 9

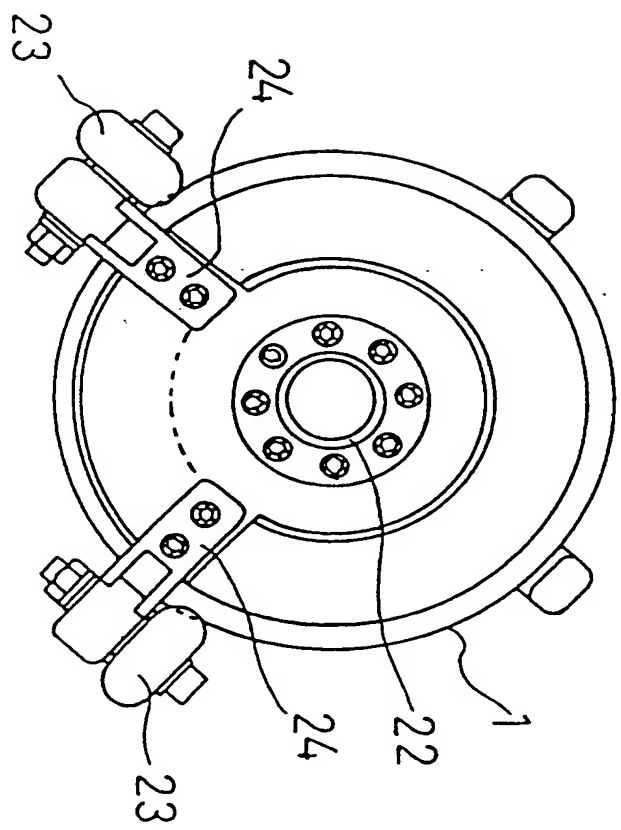




FIG. 10

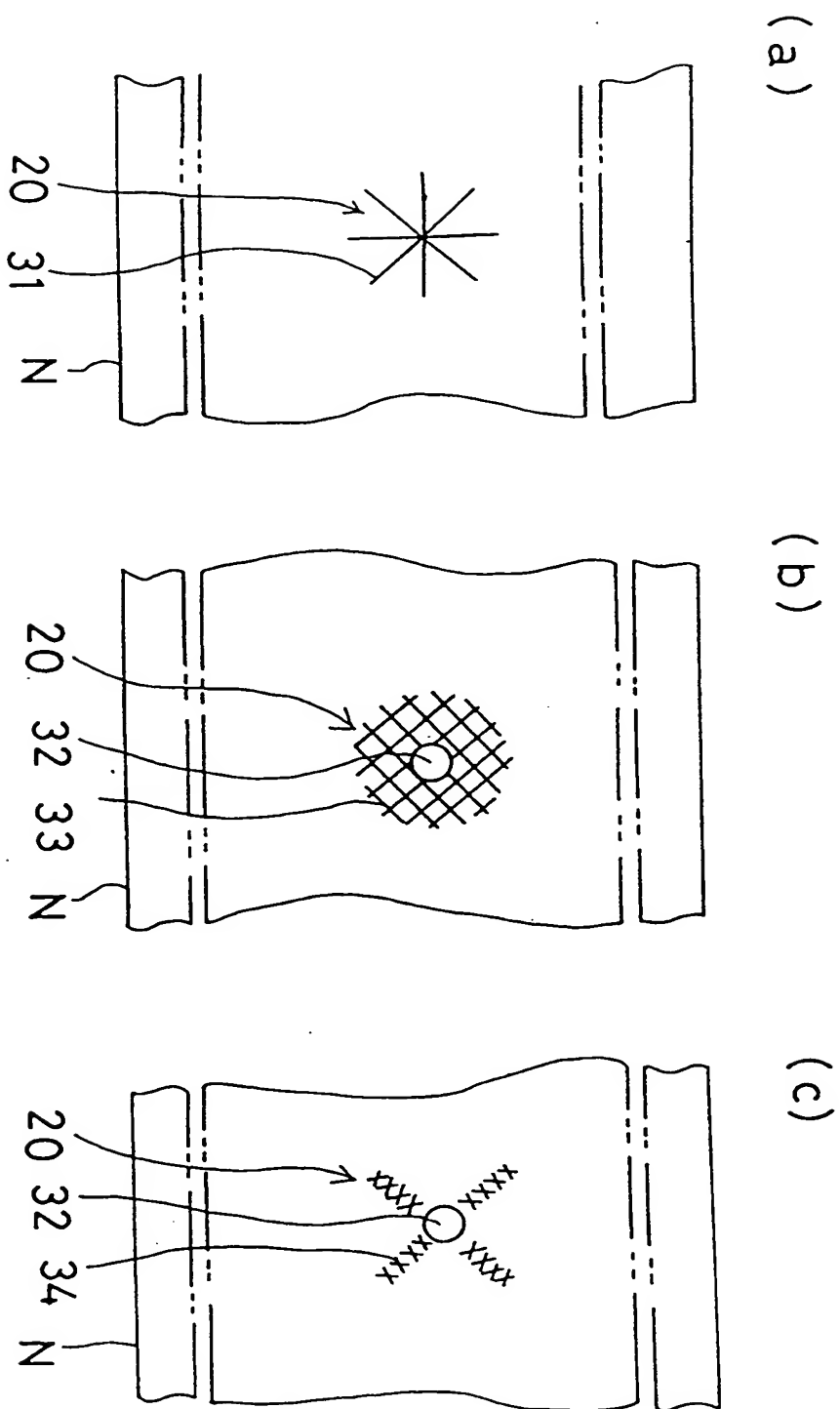


FIG 11

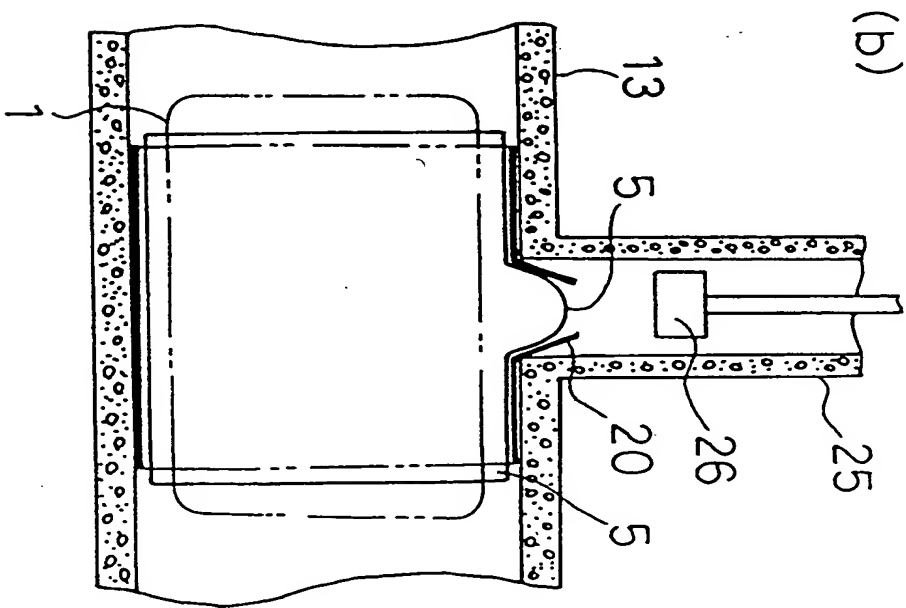
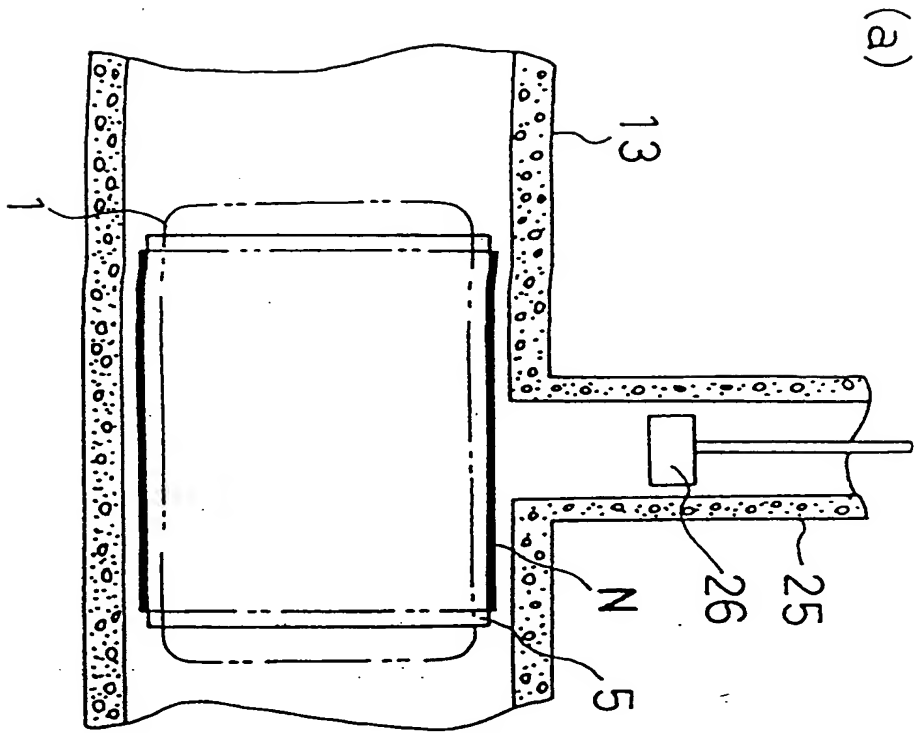


FIG. 12

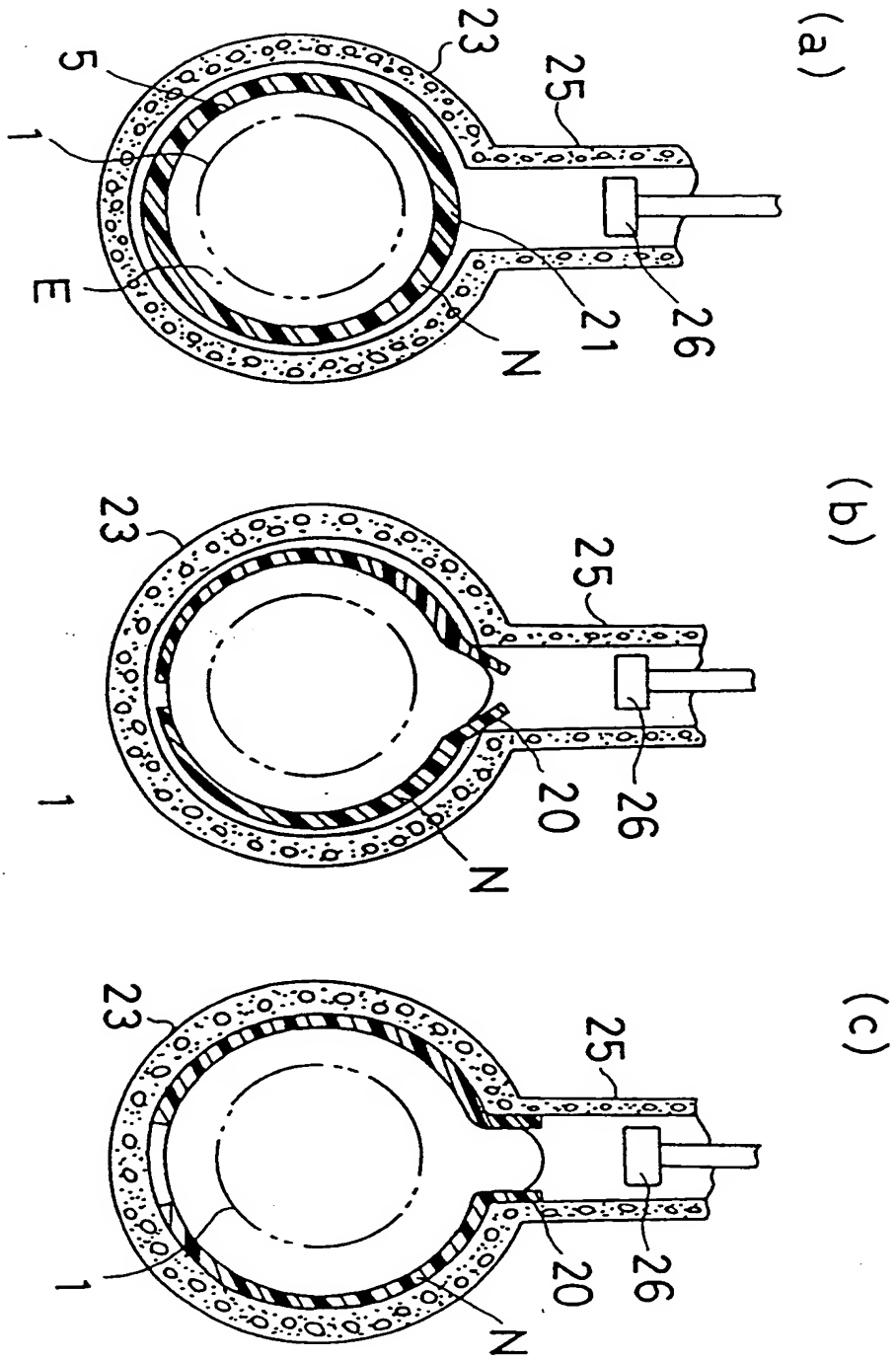
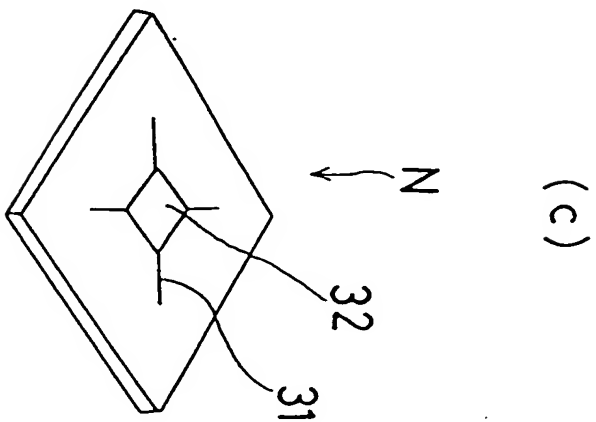
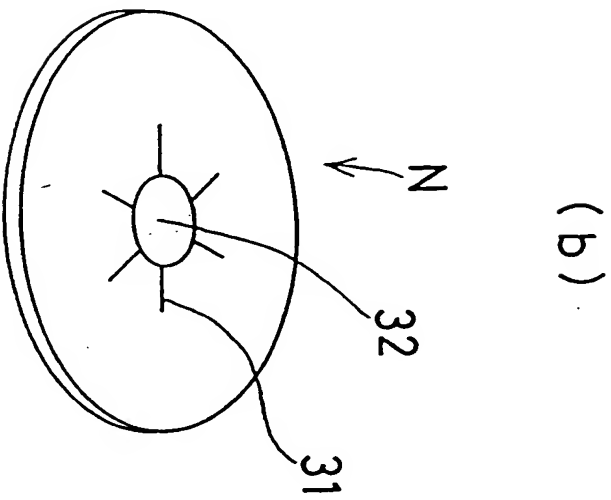
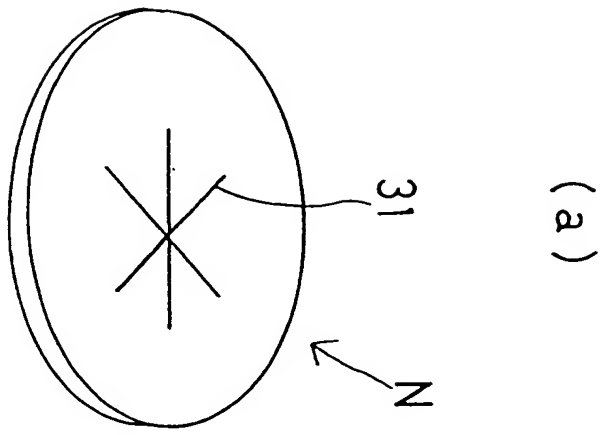


FIG 13



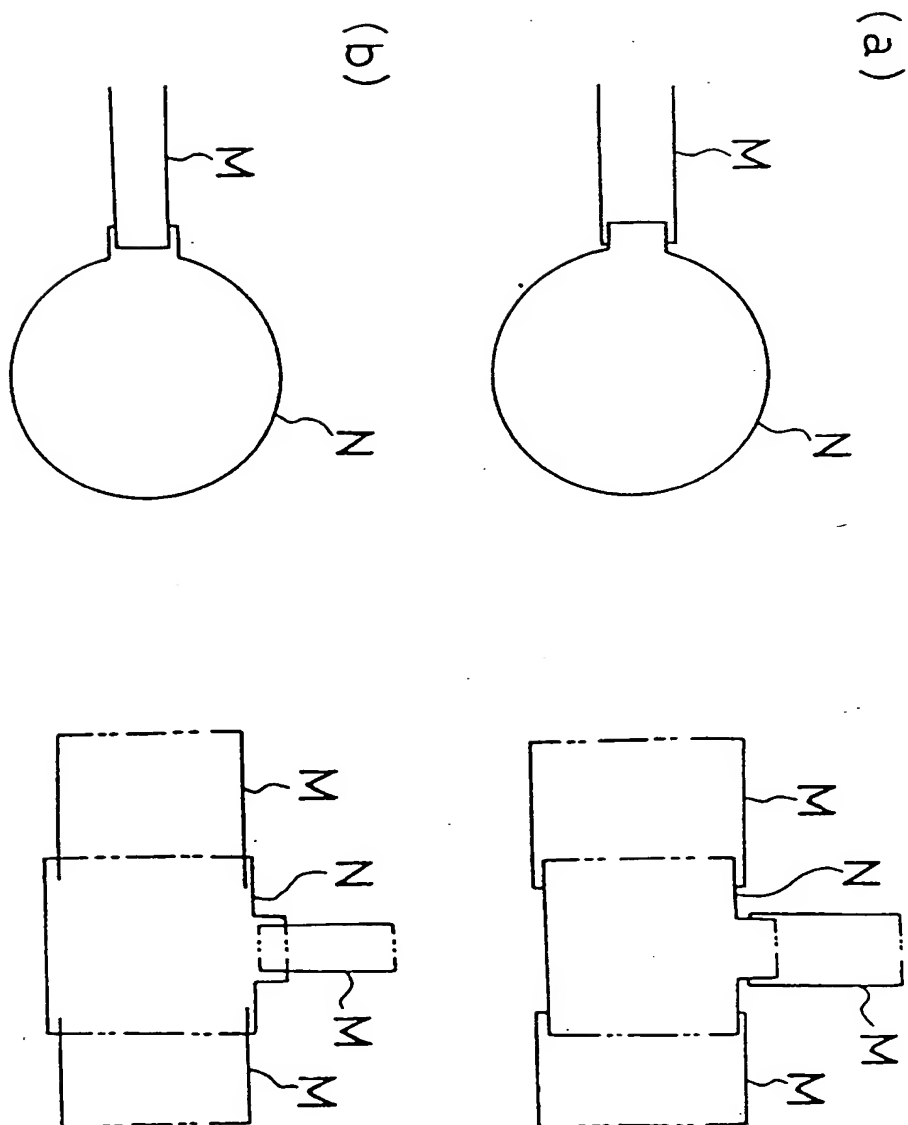


FIG. 14

FIG 15

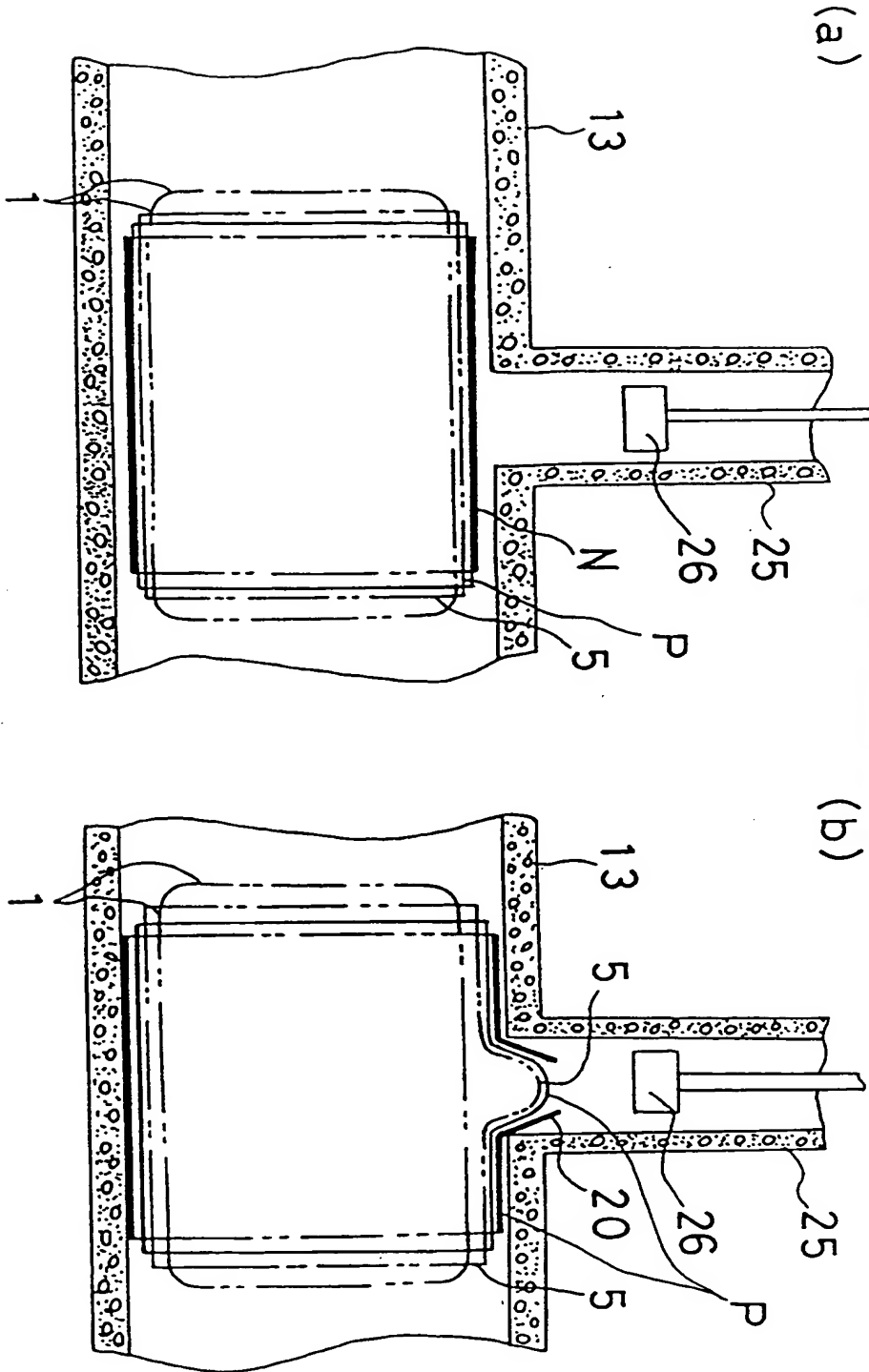
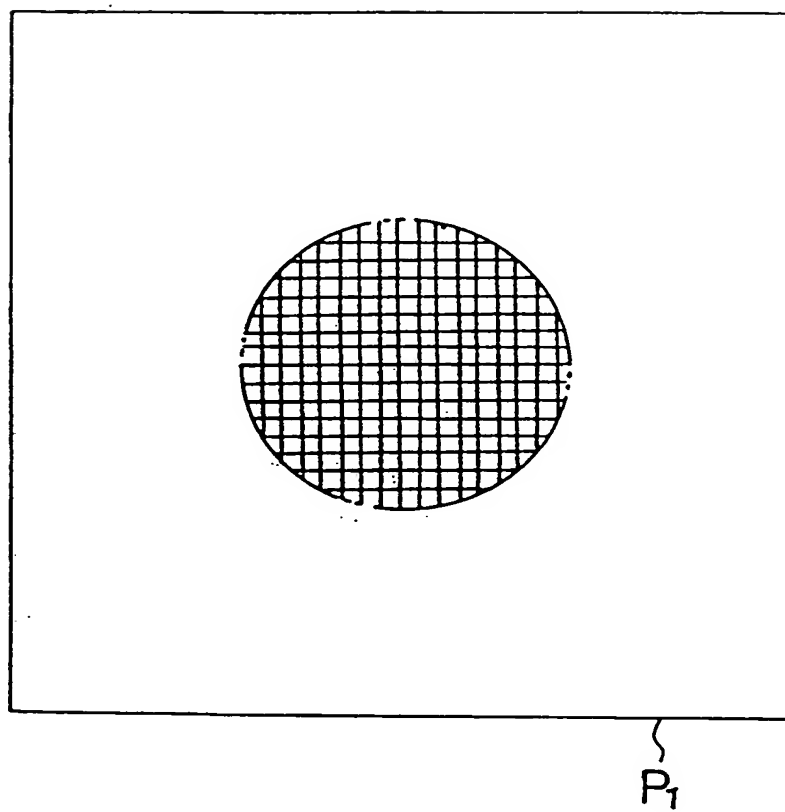


FIG 16

(a)



(b)

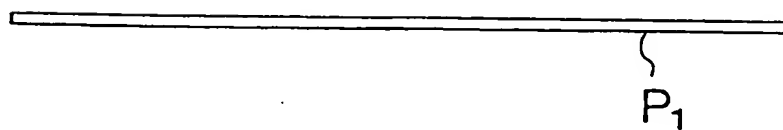
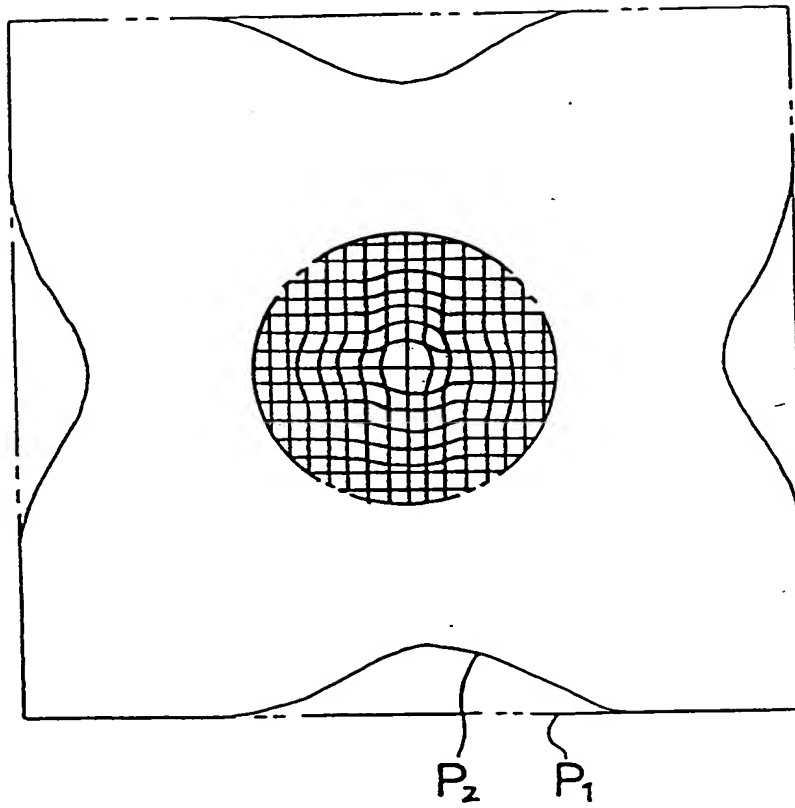


FIG 17

(a)



(b)

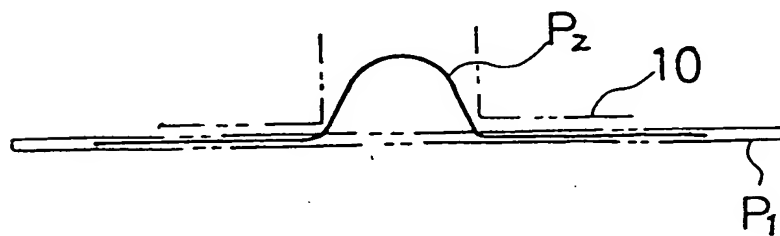
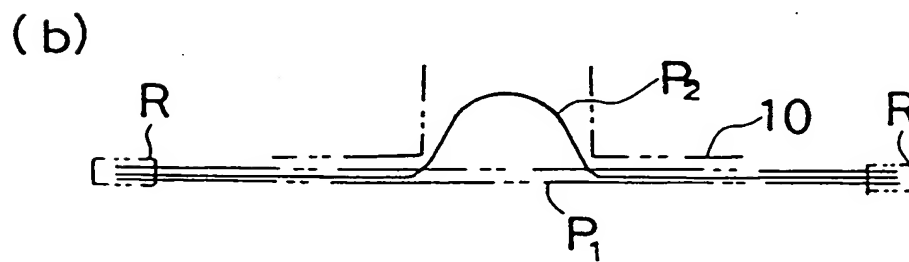
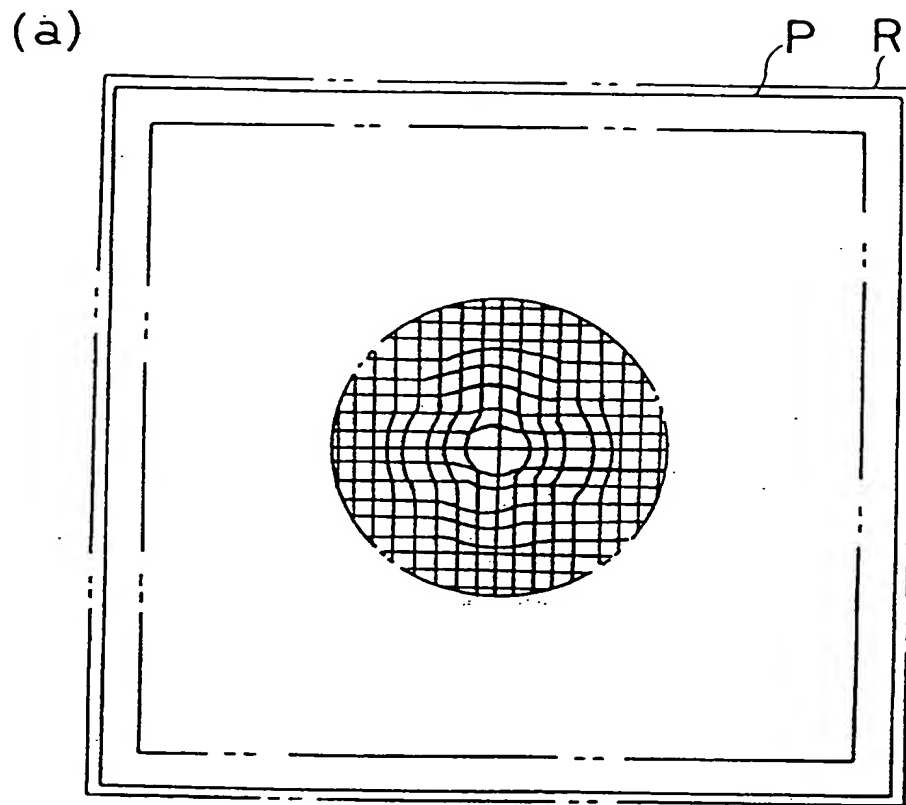




FIG 18





European Patent  
Office

# EUROPEAN SEARCH REPORT

Application Number  
EP 93 30 7158

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
X	EP-A-0 499 153 (MÜLLER) * the whole document *	6,7	F16L55/162 F16L55/18
A	---	1,2,9	
X	EP-A-0 406 876 (JT-ELEKTRONIK GMBH) * abstract; figures * * column 4, line 20 - column 5, line 37 *	7	
A	---	1,2,5,6,8	
X	DE-A-24 40 086 (MAIN-GASWERKE GMBH) * page 6, last paragraph - page 8; figures *	4,5	
A	---	1,7	
P,A	WO-A-93 16320 (INSITUFORM GROUP LTD.) * page 7, paragraph 8 - page 9, paragraph 2; figures * * page 10, paragraph 4 * * page 12, paragraph 1 - page 13, paragraph 2 *	1,2,6,7	
A	WO-A-91 04437 (UFFMANN) * abstract; figures *	8	
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 18 March 1994	Examiner Neumann, E
<b>CATEGORY OF CITED DOCUMENTS</b> X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons A : member of the same patent family, corresponding document			